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THIRTY-NINTH

ANNUAL REPORT OF THE SECRETARY

OF THE

MASSACHUSETTS

BOARD OF AGRICULTURE,

TOGETHER WITH THE

NINTH ANNUAL REPORT OF THE STATE AGRICULTURAL EXPERIMENT STATION.

1891.

BOSTON:
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1892.

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Middlesex North,	A. C. VARNUM of Lowell,	1895
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Entomologist to the Board, C. H. FERNALD, Ph.D., of Amherst.
Office of the Secretary, Commonwealth Building, Boston.

THE THIRTY-NINTH ANNUAL REPORT

OF THE

SECRETARY

OF THE

BOARD OF AGRICULTURE.

To the Senate and House of Representatives of the Commonwealth of Massachusetts: —

The year 1891 was in many respects a prosperous year for our farmers, and growers of some special crops were abundantly rewarded for their labors. Others were not so fortunate; but it is hardly to be expected that, in a State showing such a diversity of cultivated products, each grower will receive an equal annual reward for his labor.

In order that a definite and comprehensive idea of the weather and of the crops of the year past may be had, the following summaries are included in this report: —

MASSACHUSETTS WEATHER IN 1891.

In January and February there was an excess of precipitation and cloudy weather, with high temperature. In March there was also an excess of temperature and precipitation, but the number of rainy days was below the average, and there was an excess of sunshine. At the end of March the spring was considered to be from a week to ten days ahead of the average. April was warm and dry and the sunshine was in excess. The snowfall of the winter was slightly in excess. A heavy thunder-storm occurred in south-eastern Massachusetts on the evening of February 28.

At Amherst ice began to be harvested in good condition in December. Sleighing was good pretty much all winter. On the evening of February 28 snow-squalls were accompanied with frequent flashes of lightning. On the 2d and 3d of April a storm gave eleven inches of snow, lasting only a few days.

The weather for May was cold and dry, with a small number of rainy days and a slight excess of sunshine. The mean temperature was only slightly below the normal, but there were severel extensive and severe frosts, the temperature on several mornings going below the freezing point of water. Ice formed, and ground froze to the depth of one inch in places, on the 4th. On the 19th frost was especially severe except on the immediate coast. Light snow-squalls occurred in sections on the 6th.

The precipitation at seven stations in Massachusetts having records for more than ten years was 1.37 inches below the average.

Although the average temperature and total precipitation during June varied very little from the normal, the extremes of heat and cold and of drought and moisture were well marked. Hot, muggy weather and heavy rains with thunderstorms occurred on the 2d and night of the 3d. The temperature fell rapidly on the 4th, under the influence of cool, north-westerly winds, reaching the minimum for the month on the evening of the 5th. A general frost occurred on that morning, though its evil effects were somewhat checked by a thick fog that spread over most low lands. From the 5th to the 16th the weather was generally fair, with only an occasional trace of rain on the 12th, and with steadily increasing temperature from day to day. On the 16th the temperature reached nearly 100°, except at Nantucket. This degree of heat is almost unprecedented so early in the month. The drying winds that prevailed helped to make the drought very severe. The temperature fell rapidly on the 17th, and copious rains fell till the 23d, being particularly heavy on the 22d. Threatening weather, with occasional rain and low temperature, continued till the end of the month. On the 26th a thunder-storm moved easterly over southern New England, accompanied in the Connecticut valley by considerable hail.

The weather for the month of July was cool and wet, with an excess of cloudy and rainy days. Both the maximum and minimum temperatures were somewhat below the figures generally recorded, the latter unusually so. On the morning of the 28th the mercury ran down to within less than ten degrees of the freezing point of water. At Springfield the mean for the month (69.6°) was the lowest July mean recorded during a period of twenty-four years, covering from 1868 to 1891. At Fitchburg, where there is a series of observations beginning in 1857, the years 1860, 1865, and 1884 only show a July mean lower than the present, the lowest being 66.6° in 1860, just one degree lower than in 1891. The records at the weather service office in Boston show lower July means in 1881, 1884 and 1888, the lowest being in 1884, and also just one degree lower than in 1891. At Thompson, Conn., where observations for nearly half a century have been made, and with a thermometer that has hung in nearly the same position during all that time, the mean was the lowest, with one exception, ever recorded. That was in 1859, when the mean was 64.9°, less than one-half degree lower than in 1891.

The precipitation was generally heaviest and the number of rainy days greatest in the Connecticut valley, while the least precipitation fell over that section between the Connecticut valley and the coast region. Thunder-storms were not frequent or unusually severe. Hail fell at Cheshire on the 20th, during the progress of a thunder-storm.

The mean temperature for the month of August, at those stations in Massachusetts having records for more than ten years, was slightly above the normal, being somewhat in contrast with the month of July in this respect. The days of highest temperature were the 10th, 11th and 12th. The maximum was several degrees lower than was experienced in June (an unusual fact), and occurred on the 11th, except along the coast, where a well-defined sea-breeze was felt. The minimum temperature occurred generally on the morning of the 1st, but it was very cool on the 3d, 20th and the last three days of the month.

The number of cloudy and rainy days was in excess, except at Nantucket and a few other local sections, but the precipitation was nearly one inch below the average. The thunder-storms were neither frequent nor unusually heavy.

The weather for September was characterized by an exceptionally high temperature, high barometric pressure, a decided excess of sunshine, a light wind movement, a small amount of cloudiness and number of rainy days, and a deficient rainfall.

The pressure was nearly one-tenth inch above the normal. The temperature was from three to five degrees above the normal, with few excessive ranges or rapid changes. The mean temperature at New Bedford was 5.3° above the average of seventy-nine years. In the records of that station, September, 1819, 1822, 1826, 1846, 1865, and 1881, show a higher mean temperature than was registered in September, 1891. The highest temperature occurred generally on the 18th, under clear skies and with hot southerly winds. Slight frosts occurred in low lands on the 9th, doing little or no damage, but generally the night temperatures were unusually high.

The total precipitation was considerably below the normal, although a few stations along the coast reported a slight excess. The greater part of the rainfall for the month occurred in the storm of the 5th to 7th. The western section received very little rain during that storm, consequently the least precipitation was generally in the western part of the State.

The weather for Massachusetts for October was characterized by a normal pressure, excessive precipitation on the coast, high wind velocities and extremes of heat and cold. A correspondent in Randolph wrote: "Strawberry shortcake from berries picked in the open air, snakes, lightning, frost and snow, make a month of delightful irregularity." The areas of high and low pressure were generally well marked and followed each other in rapid succession across or near New England, giving, with the attendant winds, that marked influence on our weather that is so characteristic of New England falls and winters. On the 4th, under generally clear skies and warm southerly winds, a maximum temperature of from 80° to 90° was experienced. The temperature fell steadily through the 27th, and with only a slight rise on the 28th, to a very low minimum on the morning of the 29th. The first hard frost of the season occurred at many places on that morning, although light frosts were numerous during the entire month.

Four West India hurricanes reached our coast during the month, giving dangerous gales and causing considerable damage to our shipping. The storm of the 23d, which evidently originated over the Ohio valley and then moved to our southern coast, gave a very early snow-storm. In many places, where no hard frosts had been felt, the full-leaved trees loaded with snow, the many flowers in the gardens, looking up through their white blanket, and the unpicked Baldwin apples showing among the snow-covered branches, all presented an unusual sight.

The precipitation was considerably above the normal in the eastern and slightly below in the western section. At Cotuit the total rainfall for the month was 10.14 inches, 5.46 inches more than the normal for the month. A wind velocity of 40 miles an hour was registered at Boston on the 23d.

There was a deficiency of rainfall during November, no heavy rains falling until near the end of the month, and the drought which prevailed in October remained practically unbroken. Streams and wells were unusually low and in many places completely exhausted.

The average temperature was practically normal. High temperatures prevailed on the 9th to 12th and on the 17th, while an unusually low temperature was recorded on the morning of the 30th, the thermal temperature falling to within from 10 to 5 degrees of zero. Traces of snow fell during the month.

December was one of the warmest Decembers on record, the mean temperature for Massachusetts averaging about 8° above the normal for the month. Unusually high temperatures occurred on the 4th, 10th and 23d, all during southerly winds. The minimum temperature for the month occurred on the 17th, but was generally not so low as occurred in November, — an unusual occurrence. The high temperature served to keep the ground remarkably free from frost, to cause some unseasonable blossoming of plants, and to produce some dangerous forwarding of fruit buds.

The precipitation was slightly in excess, being unusually heavy during the last week of the month. Very little snow fell and none remained on the ground at the end of the month.

METEOROLOGICAL OBSERVATORY OF THE HATCH EXPERIMENT STATION, MASSACHUSETTS AGRICULTURAL COLLEGE, AMHERST.

Latitude, 42° 23 48.5" N. Longitude, 72° 31' 10" W. Height of instruments above ground 51 feet. Above sea level, 260 feet.

ANNUAL SUMMARY FOR 1891.

Pressure.

[In Inches.]

Actual max., reading,	30.44, Nov. 19, 10 A.M.
Actual min., reading,	28.40, Jan. 12, 6 A.M.
Mean reduced to sea level,	30.018
Annual range,	2.04

* *Air Temperature.*

[In degrees Fahr.]

Highest,	91.5; 94, June 16
Lowest,	0.0;-6, Feb. 15
Mean,	49.7; 49.1
Annual range,	91.5; 100
Highest mean daily,	79.6 June 15, 16; 77.3 Aug. 11.
Lowest mean daily,	11.3; 9.3, Mar. 2
Mean maximum,	57.2; 59.7
Mean minimum,	41.8; 36.7
Mean daily range,	15.4; 23
Greatest daily range,	39; 51.5, May 10
Least daily range,	2; 6.5, Mar. 9, Dec. 25

Humidity.

Mean dew point,	40.1
Mean force of vapor,	4645
Mean relative humidity,	66.8

Wind.

[Prevailing Directions.]

North,	19%
South,	13%
North-west,	12%
South, South-west,	11%
Total movement,	45,212 m.
Greatest daily movement,	443 m. Mar. 14
Least daily movement,	3 m. Jan. 1
Mean daily movement,	151.3 m
Mean hourly velocity,	6.3 m
Maximum pressure per square foot,	16¼ lbs.=57 m. per hour, Jan. 23, 3 P.M.

* *Precipitation.*

Total rainfall or melted snow,	34.82 in., 46.80 in.
Number of days on which .01 inch of rain or melted snow fell,	112
Total snow fall in inches,	54¼

Weather.

Mean cloudiness observed,	53%
Total cloudiness recorded by the sun thermometer,	2,220 hours, or 50%.
Number of clear days,	145
Number of fair days,	103
Number of cloudy days,	117

Bright Sunshine.

Number of hours recorded,	2,245
Mean ozone,	48%

Dates of Frosts.

Last,	May 19
First,	Oct. 12

Dates of Snow.

Last,	May 5
First,	Nov. 26

C. D. WARNER, *Meteorologist.*
A. T. BEALS, *Assistant.*

---

* The first figures denote readings at top of tower, the second at base.

Crops of the Year.

The general opinion of correspondents the first of June seemed to be that the month opened under less favorable conditions, agriculturally speaking, than it did last year. The month of April was quite favorable. The month of May was decidedly cool and wet, with occasional frosts, which did considerable damage to fruit and early crops in many sections. Almost every correspondent reported the presence of the tent caterpillar, and that steps had been taken by many farmers to destroy the pest, while others did nothing. Nearly all the correspondents reported first-class farm help as quite difficult to obtain, and that $20 to $25 per month and board was a fair average of the wages paid such help.

The 1st of July it was believed that on the whole the season compared favorably with last season. Haying had very generally commenced, but grass was late and the weather had been unfavorable for curing, so that little had been secured. The general opinion seemed to be that dairy products had been a little less in quantity, of about the same quality and with a little better price than last year. The strawberry crop was hardly over two-thirds of an average.

August 1 most of the correspondents reported the hay crop as being entirely secured. The crop was estimated to be about three-fourths of an average. The quality as a whole was excellent. The general opinion was that the crop of fall apples would be large, while the crop of winter varieties would be considerably below the average, and that the yield of small fruits was slightly below the average, while prices were a full average. The quality was generally good. Early potatoes had been generally harvested, and most correspondents reported a good yield of good quality. A few cases of blight and rot were reported. Rye was reported as generally satisfactory both in quality and quantity. Pastures had been injured by lack of rain. On the whole, the condition August 1 was favorable, and the season so far fairly prosperous for the farmer.

September 1 nearly all the correspondents stated that they had observed either blight or rot on potatoes. Most reported the condition of dairy stock as being either excellent, good or average. To the question, "Has dairying been as profitable this year as usual?" 72 correspondents answered yes; 39, no; and 10 stated it to have been more profitable. The chief drawbacks were shortness of pasture feed and high price of grain. Of the 70 direct replies to the question, "Do you think the dairy interests of the State are seriously affected by the manufacture and sale of oleomargarine?" 56 were yes, and 14, no. A portion of the tobacco crop had been harvested in good condition, and considerable had already been sold at unusually high prices. The pear crop was reported to be very large.

October 1, 24 correspondents stated the crop of Indian corn to be above an average; 81, a full average; and 12, below an average. Practically the same figures illustrated the yield and quality of the crop of late potatoes. Sixty-seven correspondents, mostly in the western part of the State, stated that the average amount of fall seeding had been done, and 35, mostly in south-eastern Massachusetts, that it had not, owing to dry weather. Forty-six correspondents reported the cranberry crop to be an average in yield and quality, and 31 that it was not. Drawbacks mentioned were dry weather while in bloom, late frosts, and worms. Tobacco had cured well. Of 113 replies to the question, "Are inquiries for and values of farm property increasing or decreasing in your neighborhood?" 58 noted an increase; 42, no appreciable change; and 13, a decrease.

In the circular to correspondents returnable October 29 the first question asked was, "Have root crops done as well this year as usual?" Of the 114 replies to this question, 88 answered yes; 13, no; and 13 stated that they had done better than usual. Several correspondents reported root crops had been injured by drought, and several that turnips had turned black in the field and were of small size.

The second question asked was, "Which of the leading crops of your locality do you think have been least profitable this year?" and the third question asked was, "Which of the leading crops of your locality do you think have been most profitable?" Fifty-seven correspondents stated corn to be among the most profitable crops this year, and 5 stated it to be among the least profitable; for potatoes, 23 most profitable and 37 least profitable; for hay, 24 most profitable and 27 least profitable; for apples, 5 most profitable, and 19 least profitable; for tobacco, 13 most profitable; for pears, 7 least profitable; for rye, 2 most profitable; for oats, 5 most profitable and 1 least profitable; for onions, 6 most profitable and 2 least profitable.

The fourth question asked was, "Considered as a whole, has the season been a profitable one for your farmers?" Of the 116 replies to this question, 80 stated it to have been a profitable one; 12, that it had been an average season; 6, that it had been a fairly prosperous season; 9, that it had been more prosperous than usual; and 9, that it had not been a profitable season.

The fifth question asked was, "Do you think farmers anticipate an increase of prosperity in their business in the near future?" Of the direct replies to this question, 79 correspondents stated that they did think farmers anticipated an increase of prosperity in their business in the near future, and 20 that they did not think so. It was estimated that the farmers in the Housatonic and Connecticut valleys alone would receive at least $1,400,000 more for their tobacco crop than they did last year, an increase of over eighty-seven per cent.

Massachusetts Crop Reports.

The issue of these monthly bulletins or reports began in June, 1888, and about four hundred copies of the first number were printed. Five bulletins were issued in 1888, six in 1889, six in 1890, and six in 1891. For September, 1891, 2,400 copies of the bulletin were printed and distributed. The bulletin for June, 1888, contained 13 printed pages, while each bulletin the past year contained 28 pages.

The special subjects treated the past season were: Bulletin No. 1, Tuberculosis; Bulletin No. 2, The Gypsy Moth; Bulletin No. 3, Yields and Values per Acre of Crops in Massachusetts as compared with Other States; Bulletin No. 4, Oleomargarine; Bulletin No. 5, Abandoned Farms in Massachusetts.

Two pages on Massachusetts weather, prepared by an expert, were included in each bulletin; and since Bulletin No. 2 (June) a weekly statement of condition of crops in this section and of temperature and rainfall for the whole country, from the United States Weather-Crop Bulletins, was included in each issue. Since the same date an abstract of the monthly reports of the statistician of the United States Department of Agriculture of the condition of crops in Massachusetts at the beginning of each month was also included.

PUBLICATIONS.

The following publications were issued under the supervision of this office during the calendar year 1891: —

NAME	Pages.	Number.	Date of Issue.
Agriculture of Massachusetts, 1890, .	776*	15,000	April 10.
Insecticides and their Application, . .	16	2,500	April 30.
Bulletin of Information, Gypsy Moth, .	16	3,000	June 16.
Crop Bulletin No. 1. May, . . .	28	2,200	June 6.
" " No. 2. June, . . .	28	2,000	July 9.
" " No. 3. July, . . .	28	2,000	August 6.
" " No. 4. August, . .	28	2,000	September 5.
" " No. 5. September, . .	28	2,400	October 6.
" " No. 6. October, . .	28	2,000	November 7.
Catalogue of Abandoned or Partially Abandoned Farms, ...	104	3,000	December 4.

LEGISLATION.

The legislation of the year 1891 that had reference to the Board of Agriculture or to the agricultural societies was an act relative to preserving ornamental and shade trees on the highways, amendment to Acts of 1890, chapter 196, section 2 (Acts of 1891, chapter 49); a resolve providing for nails or spikes for designating certain trees on highways for preservation (Resolves of 1891, chapter 72); an act to incorporate the Weymouth Agricultural and Industrial Society (Acts of 1891, chapter 77); a resolve in favor of the Weymouth Agricultural and Industrial Society, providing for the payment of $463.55 bounty (Resolves of 1891, chapter 32); an act relative to the filing of certificates by agricultural societies, amendment to Public Statutes, chapter 114, section 2 (Acts of 1891, chapter 124); an act to authorize the State Board of Agriculture to collect and circulate information relating to abandoned farms (Acts of 1891, chapter 280); an act to authorize the secretary of the State Board of Agriculture to employ an assistant clerk (Acts of 1891, chapter 300); a resolve providing for an investigation by the State Board of Agriculture into the dangers arising from tuberculosis in the food products of cattle (Acts of 1891, chapter 118); An act to provide against depredations by the insect known as the *Ocneria dispar* or Gypsy Moth (Acts of 1891, chapter 210); and an act to provide for the protection of dairy products and to establish a State Dairy Bureau (Acts of 1891, chapter 412).

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* Including Annual Report of Director of the State Agricultural Experiment Station, 324 pages.

APPROPRIATIONS.

OBJECTS FOR WHICH APPROPRIATED.	1889.		1890.		1891.		1892.
	Appropriated.	Used.	Appropriated.	Used.	Appropriated.	Used.	Appropriated.
Bounties to societies, . .	$19,800 00	$19,396 30	$20,400 00	$19,623 62	$21,000 00	$20,338 65	$21,500 00
Traveling and necessary expenses of the Board, . .	1,900 00	1,374 72	1,900 00	1,615 32	1,900 00	1,779 11	1,900 00
Traveling and necessary expenses of the secretary, .	500 00	500 00	500 00	500 00	500 00	500 00	500 00
Incidentals, office of secretary, . .	500 00	500 00	500 00	500 00	500 00	500 00	500 00
Salaries of secretary and clerks, . .	3,700 00	3,700 00	3,700 00	3,700 00	4,372 21	4,372 21	5,200 00
Dissemination of useful information in agriculture by means of lectures or otherwise, . .	2,000 00	1,997 42	2,200 00	2,198 69	2,200 00	2,200 00	2,200 00
Printing 15,000 copies of the "Agriculture of Massachusetts." . .	7,305 00	7,305 00	6,729 37	6,729 37	5,974 00	5,974 00	* 6,500 00
Collecting and circulating information relative to abandoned farms, . .	-	-	-	-	2,000 00	676 62	† 1,323 38
Carrying forward work of Dairy Bureau.	-	-	-	-	4,000 00	903 05	4,000 00
Salary of assistant in work of Dairy Bureau, . .	-	-	-	-	400 00	400 00	1,200 00
Nails or spikes for marking trees for preservation, .	-	-	-	-	100 00	62 69	100 00
Aggregates,	$35,705 00	$34,773 44	$35,929 37	$34,867 00	$42,946 21	$37,706 33	$44,923 38

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* Estimated. † Balance.

Also $50,000 was appropriated to be used in the extermination of the Gypsy Moth. The unexpended balance of the year 1890 amounting to $24,460.68 was joined to this, making a total of $74,460.68 of which $69, 247.55 was used. The appropriation for 1892 is $75,000.

NAILS FOR MARKING TREES.

By chapter 49 of the Acts of 1891 it was made the duty of the secretary of the Board of Agriculture to procure and furnish nails or spikes, with a head with the letter M plainly impressed upon each, to mayors and aldermen of cities and selectmen of towns, as required by them for the purposes of the act. The law went into effect the first day of September, 1891. Early in the season, after the passage of the act, effort was made to decide upon and secure the requisite nails. Delay after delay was experienced, and it was nearly the first of January before the nails could be sent to the towns having made requests for them. Three sizes of nails were ordered, two and one-quarter, two and three-quarters, and three and one-quarter inches in length. Two sizes of tinned washers were ordered to be used with the nails.

The following table will show the towns which requested nails, and the number of each size sent: —

TOWN.	Large.	Medium.	Small.	Total Nails.	Large Washers.	Small Washers.	Total Washers.
Abington, .	25	50	25	100	25	50	75
Bedford, .	350	500	250	1,100	650	450	1,100
Berlin, . .	300	300	300	900	300	600	900
Bolton, . .	50	100	50	200	50	100	150
Falmouth, .	150	200	150	500	150	350	500
Lancaster, .	150	200	150	500	150	350	500
Ludlow, . .	150	200	150	500	150	350	500
Northbridge, .	50	50	50	150	50	100	150
Orleans, . .	25	50	25	100	25	75	100
Pembroke, .	50	100	50	200	50	150	200
Rockport, .	25	50	25	100	25	50	75
Townsend, .	450	600	450	1,500	450	1,050	1,500
Wenham, .	50	–	25	75	50	25	75
Westford, .	1,500	2,000	1,500	5,000	1,500	3,500	5,000
Yarmouth, .	150	200	150	500	150	350	500
Aggregates,	3,475	4,600	3,350	11,425	3,775	7,550	11,325

The Legislature of 1891 appropriated $100 for the supplying of these nails; $62.69 of this amount has been expended as follows: —

Two hundred and thirty-seven pounds 3¼, 254 pounds 2¾, 126 pounds 2¼, equal to 617 pounds nails, at 6 cents,	$37	02
One hundred and fifty pounds large tinned washers, at 12 cents,	16	50
Sixty-six pounds small tinned washers, at 12 cents,	7	92
Express charges,	1	25
	$62	69

Quite a quantity of nails and washers, particularly the larger sizes, remain in the office of the secretary subject to future calls. Others will be secured as needed.

Dairy Bureau.

The Legislature of 1891, by chapter 412, enacted a law providing for the protection of dairy products and for the establishing of a State Dairy Bureau. In order to secure the better enforcement of the provisions of the act and to promote the improvement of the products of the dairy, the Governor, by and with the advice and consent of the Council, was given authority to appoint three members of the Board of Agriculture, to constitute a Dairy Bureau of said Board, to serve without pay. It was also provided that the said Bureau, in the discharge of its duties, should be subject to the general direction and control of the Board of Agriculture. The Governor appointed Messrs. C. L. Hartshorn of Worcester, G. L. Clemence of Southbridge and D. A. Horton of Northampton as the Bureau. Their report to the Legislature will be found printed on pages 313–318 of this volume.

Gypsy Moth (*Ocneria dispar*).

On March 4, 1891, N. S. Shaler and Francis H. Appleton, members of the Board of Agriculture, and William R. Sessions, secretary of said Board, were appointed commissioners to provide and carry into execution measures to secure the extermination of the *Ocneria dispar* or gypsy moth in this Commonwealth. This commission was superseded by the Board of Agriculture by chapter 210 of the

Acts of 1891, which was approved April 17, 1891. This act placed the work in the hands of the State Board of Agriculture. At a meeting of the Board, April 28, 1891, William R. Sessions, N. S. Shaler and Francis H. Appleton were chosen "a committee with full power to exercise all the duties and powers conferred upon the Board of Agriculture by an act to provide against the depredations of the insect known as the *Ocneria dispar* or gypsy moth." This committee organized May 19, 1891, by choosing William R. Sessions chairman and secretary. The report of this committee to the Legislature (House Document No. 25), will be found printed on pages 287–312 of this volume.

Abandoned Farms.

One result of the efforts of the States of Vermont and New Hampshire to call attention to their abandoned farms was that the friends of agriculture and the newspapers of this State asked for an effort in the same direction by the Legislature of Massachusetts.

It should also be noted that the Pittsfield Board of Trade has done much to call attention to this class of property in Berkshire County, and newspapers in several sections have published descriptions of such property and articles relating thereto.

For two years or more this office has been anxious to do something to call attention to such farms in Massachusetts. In the report of the secretary of the Board of Agriculture to the Legislature, January, 1890, it was suggested that, if the Legislature would appropriate a small sum for the expense, and give some officer authority to collect information, good results might be realized. This suggestion was repeated in January, 1891. At the annual meeting of the Board of Agriculture, February 5, it was "*Voted*, That the State Board of Agriculture petition the Legislature, now in session, for such legislation as will provide for ascertaining the number, location, value and other facts pertaining to the abandoned farms and farm lands in the State; also the most effective method of securing their reoccupancy." The Legislature of 1891 enacted the following law:—

[Chap. 280]

An Act to authorize the State Board of Agriculture to collect and circulate information relating to abandoned farms.

Be it enacted etc., as follows:

Section 1. The State Board of Agriculture is hereby authorized to collect all necessary information in regard to the opportunities for developing the agricultural resources of the Commonwealth through the repopulating of abandoned or partially abandoned farms, and cause the facts obtained, and a statement of the advantages offered, to be circulated where and in such manner as the said board may consider for the best interests of the Commonwealth.

Sect. 2. In order to properly carry out the provisions of section one of this act, a sum not exceeding two thousand dollars may be expended, and the bills for such expenditures properly approved by the persons authorized by said State Board to investigate the matter, shall be sent to the Auditor of the Commonwealth, who shall certify them in the same manner as other claims against the Commonwealth.

Sect. 3. This act shall take effect upon its passage.

Approved May 4, 1891.

At a meeting of the executive committee, May 21, 1891, it was "*Voted*, That the secretary be instructed to prepare a circular for transmission to the assessors of the several cities and towns of the Commonwealth, asking said assessors to return to the State Board of Agriculture, upon a blank prepared for the purpose, the names of the owners of abandoned or partially abandoned farms situated in different parts of the State." Accordingly the following circular was prepared and sent to each of the cities and towns in the Commonwealth: —

COMMONWEALTH OF MASSACHUSETTS.

State Board of Agriculture, Secretary's Office,
Commonwealth Building, Boston, June 16, 1891.

To the Assessors of Massachusetts.

Gentlemen: — The following law has been enacted by the Legislature: —

(Acts of 1891, chapter 280, sections 1, 2, 3.)

The object is to make known opportunities for the purchase, at a low price, of farms in Massachusetts. You will of course notice that the law does not require you to assist in the work, but it is believed that you will be interested in a scheme which has for its end the prosperity of your towns, and will be willing to help the Board of Agriculture in gathering information that can be spread before the public to the advantage of the owners of abandoned or partially abandoned farms, and of would-be purchasers.

The towns which contain such farms will be benefited by having them owned and improved by persons residing upon them. The plan of action is not yet fully matured; but, without question, the first thing to be done is to get a list and description of such farms.

As the assessors are better acquainted with such lands and their owners than are any other citizens, we apply to you for information. The law makes it our duty to obtain information and circulate the same in regard to abandoned or partially abandoned farms in the Commonwealth.

We must leave it largely to your judgment to interpret the phrase "partially abandoned farms," but would suggest that a farm which is not occupied for purposes of cultivation or a summer home, and is for sale at a low price, might be called an abandoned or partially abandoned farm.

It will of course be of little use to call attention to farms that have been so long abandoned that the buildings have disappeared and the land mostly grown up to brush and wood; but sizable tracts of land suitable for purposes of cultivation or for grazing, though without buildings, should be considered. It will also be of little use to call attention to farms that are not on the market for what would be called a low price in proportion to their productive capacity.

Will you kindly write in the enclosed blank the names and post-office addresses of the owners of such farms, in your town, as may seem to you to come within the meaning of the law? We shall issue a circular of inquiry for particular description, location, price, etc., to the owners whose names you may furnish us. We will keep you informed of the progress of the work, and shall very likely need your further aid. Any suggestions will be gladly received and considered.

In order that the necessary information from the owners may be seasonably obtained, it will be necessary that this blank be returned before July 1, 1891. If you have no farms that seem to you to come within the meaning of the law, please return the blank with such remarks thereon as will describe the situation in your town.

THE MASSACHUSETTS STATE BOARD OF AGRICULTURE.

WM. R. SESSIONS, *Secretary.*

The following table gives the number of abandoned or partially abandoned farms by counties, as reported by the assessors of the several cities and towns in response to the circular letter; number of cities and towns in each county, and the number reporting abandoned or partially abandoned farms: —

COUNTIES.	Number of Cities and Towns in County.	Number Not Reporting.	Number Reporting Abandoned or Partially Abandoned Farms.	Number of Abandoned or Partially Abandoned Farms Reported.
Berkshire,	32	1	17	140
Franklin,	26	–	17	103
Hampshire,	23	2	11	86
Hampden,	22	–	10	83
Worcester,	59	1	30	249
Middlesex,	54	–	17	51
Essex,	35	–	3	11
Suffolk,	4	–	–	–
Norfolk,	27	1	8	39
Bristol,	20	1	6	49
Plymouth,	27	1	10	33
Barnstable,	15	–	3	29
Dukes,	6	–	2	8
Nantucket,	1	–	1	6
Aggregates,	351	7	135	887

As a rule, the assessors were quite prompt in sending in their returns. In some cases, however, it was found necessary to send a second request, and in a few, a third. No doubt there has been considerable variation in the standard adopted in different towns. In some towns farms have been reported that should not have been, while in others some have been omitted that properly belong in the list.

The work was continued by the sending of the following circular letter to the owners or agents of the abandoned or partially abandoned farms reported by the assessors: —

STATE BOARD OF AGRICULTURE, SECRETARY'S OFFICE,
COMMONWEALTH BUILDING, BOSTON, Aug. 25, 1891.

To the Owners of Abandoned or Partially Abandoned Farms in Massachusetts.

GENTLEMEN: — The Legislature at its last session enacted the following law: —

(Acts of 1891, chapter 280, sections 1, 2, 3.)

In discharge of the duty devolving upon the Board of Agriculture under the provisions of this statute, a circular has been addressed to the assessors of the several cities and towns of the State, asking them to report to this Board the names of the owners of abandoned or partially abandoned farms. Your name has been reported by the assessors of ——— as the owner of such property. If you desire to dispose of the property, please answer the following questions in regard to the same, subscribe to the affidavit below before a justice of the peace, and forward it in the enclosed envelope. This description and affidavit will be retained in this office for reference. A catalogue of such farms, with description and price, will be printed and widely distributed. There will be no expense to the owners of the property. Please be prompt in replying, as nothing further can be done by us until all information has been received.

THE MASSACHUSETTS STATE BOARD OF AGRICULTURE,
Wm. R. Sessions, *Secretary.*

Report of Abandoned or Partially Abandoned Farm.

Located in town of.
Total acreage.
Acres of mowing land.
Acres in pasturage.
Acres in woodland.
Acres suitable for cultivation.
Can grass be cut with a machine?
Is there a sugar bush? Number of trees.
Size of house, if any.
Size of L.
Number of rooms.
Is house in good repair?
Size of barn, if any.
Is there a barn cellar?
Is the barn in good repair?
What kind of fences and in what condition?
What is the water supply?
Number of apple trees.
Number of other fruit trees.
Name of nearest railroad station and distance from farm.
Name of nearest post-office and distance from farm.
Price at which farm will be sold.
Amount required in cash.
The balance can remain on mortgage at what rate of interest?
State any facts of interest.

I hereby certify that the above statements in regard to the farm owned by me in the town of __________ are true to my best knowledge and belief, and that any time within one year of the date hereof I will sell said farm for the price and on the terms named, unless previously disposed of.

__________________ *Owner or Agent.*

Date__________ P. O. Address__________

Before me,

____
Justice of the Peace.

The descriptions not coming in as rapidly as was desired, the following circular was issued: —

COMMONWEALTH OF MASSACHUSETTS.

State Board of Agriculture, Secretary's Office,
Commonwealth Building, Boston, Oct 14, 1891.

Dear Sir: — Under date of August 25 last we mailed you a copy of the enclosed circular, hoping to receive a description of an abandoned or partially abandoned farm which the assessors of —— reported you to be the owner of. We have received no description of said farm from you, and we earnestly urge you to send us such description at once, if you wish to have the farm noticed in the catalogue. If you do not wish to dispose of it in this way, kindly notify us. We are anxious to issue the catalogue of description at an early date, but we do not feel warranted in so doing until all descriptions asked for have been heard from.

THE MASSACHUSETTS STATE BOARD OF AGRICULTURE.
Wm. R. Sessions, *Secretary.*

It was again found necessary to request the delinquents to either forward descriptions of their property or notify us that they did not wish to have it advertised in the catalogue. Accordingly another notice was mailed November 1, with the written request to reply at once. The following table shows the results of these efforts to obtain descriptions of the 887 farms reported by the assessors, including also 19 reported from other sources, or a total of 906 farms: —

Counties.	Number of Abandoned or Partially Abandoned Farms Reported.	Number of Owners or Agents Making Reply.	Number of Descriptions of such Property Received.	Number Reporting as not Wishing to Sell or Advertise in Catalogue.	Number Reporting Farm Sold.	Number Reporting Assessors to have been Misinformed.	Returned by Post-office Department as Unclaimed.
Berkshire,	146	89	65	18	5	1	22
Franklin,	103	64	40	14	3	7	6
Hampshire,	87	49	27	17	3	2	7
Hampden,	84	53	31	16	3	3	2
Worcester,	256	172	101	43	15	13	16
Middlesex,	52	23	14	7	2	–	4
Essex,	11	3	1	2	–	–	2
Suffolk,	–	–	–	–	–	–	–
Norfolk,	40	25	13	7	3	2	10
Bristol,	50	24	9	13	1	1	5
Plymouth,	33	25	18	2	4	1	2
Barnstable,	29	7	2	2	2	1	1
Dukes,	9	7	4	3	–	–	–
Nantucket,	6	6	3	3	–	–	–
Aggregates,	906	547	328	147	41	31	77

About the middle of November it was thought best to go ahead and issue a descriptive catalogue, although but 547 of the 906 farms had been heard from. Accordingly this was done, and December 4 there was issued from this office a pamphlet of 104 pages, containing a map of the State, an outline of the work to date, results of similar work by the Bureau of Labor, physical characteristics of the State, statistics of education and agriculture, and descriptions of 328 farms. Three thousand copies were printed, about 1,000 of which were sent to owners or agents of the property described, to assessors, and to members of the Board of Agriculture and the agricultural societies; the other 2,000 were sent or given only upon request. The edition was soon exhausted, and it was found necessary to have another printed. As the first edition was stereotyped, this was readily and cheaply done. The second edition of 1,500 copies was ready for distribution Feb. 1, 1892. In this edition descriptions of nine farms were added. In all, 1,500 requests for the catalogue have been received by mail, or an average of 125 per week for the twelve weeks. To date, March 1, 3,900 of the 4,500 catalogues have been distributed. The following summary will show the disposition made: Massachusetts, 2,902; Maine, 34; New Hampshire, 62; Vermont, 15; Rhode Island, 44; Connecticut, 103; New York, 382; New Jersey, 47; Pennsylvania, 36; Delaware, 3; District of Columbia, 19; Maryland 5; Virginia, 9; West Virginia, 2; North Carolina, 2; South Carolina, 1; Georgia, 3; Florida, 9; Alabama, 2; Mississippi, 1; Texas, 3; Arkansas, 1; Missouri, 8; Kentucky, 2; Tennessee, 1; Ohio, 33; Indiana, 9; Illinois, 28; Michigan, 31, Wisconsin, 9; Minnesota, 11; Iowa, 7; North Dakota, 4; South Dakota, 5; Kansas, 16; Nebraska, 15; Utah, 1; Colorado, 1; Washington, 1; Oregon, 2; California, 7; Canada, 22; and England, 1.

Many letters, a number from non-residents, have been received, expressing an interest in the work and the hope that good results would be secured. This office has recently been notified that the Connecticut authorities were soon to enter upon a similar line of work.

It is too early to state what has been accomplished by this line of work, but it is believed that the results will in the end be to the advantage of the Commonwealth.

Tuberculosis.

By chapter 118 of the Resolves of 1891, the Legislature instructed the State Board of Agriculture to investigate and ascertain the best methods to be adopted in order to protect the citizens of this Commonwealth against the dangers to human life and health arising from the presence of tuberculosis in the food products of cattle. The Board was authorized to expend in this work a sum not exceeding twenty-five hundred dollars. None of this money has been used. The Board thought it best to present its recommendations to the Legislature in a report, instead of expending the money appropriated. This report will be found printed on pages 373–376 of this volume. Attention is also called to the annual report of the Commissioners on Contagious Diseases among Domestic Animals, which is printed in the Appendix, pages 442–455. This report is devoted largely to the consideration of bovine tuberculosis.

Agricultural College.

The report of the examining committee of the Agricultural College will be found printed on pages 370–372 of this volume.

Returns of Societies.

It will be noticed that the returns of the societies are arranged in a different manner from previous years. It is thought that the change will prove a desirable one, as the condition and work of each society can be more readily seen than when the returns are tabulated. These returns will be found on pages 321–354 of this volume. The summary on page 355 gives a number of very interesting facts concerning the societies.

Farmers' Institutes.

The societies held one hundred and forty-one farmers' institutes during the year 1891. All held the three required by the Board, and several held six or more. The places and dates of these institutes and also the subjects considered will be found in the returns of the societies. A provision of the law enables this office to supply speakers for institutes, but by a regulation of the Board the secretary is not allowed to furnish more than one speaker at each institute. During the year 1891 this office furnished speakers for eighty farmers' institutes. The secretary of the Board spoke at twelve institutes during the year.

Meetings of the Board.

A special business meeting of the Board was held at the office of the secretary, April 28, 1891. It was called to consider and act upon matters of legislation concerning the gypsy moth, abandoned farms, tuberculosis, and the Dairy Bureau.

The public winter meeting of the board for lectures and discussions was held at Horticultural Hall, Boston, Dec. 1, 2 and 3, 1891. The attendance at this meeting was very good, and the lectures and discussions were of a high order. A special business meeting of the Board was held at the Hall, December 2. The records of these meetings and the lectures and discussions of the public winter meeting will be found printed on pages 1–285 of this volume.

The regular annual meeting of the Board was held at the office of the secretary, Feb. 2, 3 and 4, 1892, and the minutes thereof, reports adopted and essays read, will be found printed on pages 359–418 of this volume.

Agricultural Directory.

A directory of the agricultural associations, with officers, has been prepared at considerable labor, and will be found printed on pages 421–433. It is hoped that this directory will be of value to the officers of these several organizations and to others. It is further hoped that it may be made a permanent feature of the report, and that this office will be notified of changes in officers, etc.

In the Appendix will be found a report of the National Farmers' Congress at Sedalia, Mo., Nov. 10–12, 1891, made to His Excellency the Governor by Hon. Daniel Needham of Groton. This report was transmitted to the secretary of the Board of Agriculture by His Excellency the Governor, with the request that it be included in this volume.

During the past year one of the most efficient members of the Board, and one of the oldest in point of service, Mr. E. F. Bowditch of Framingham, was removed by death. He represented the Massachusetts Society for the Promotion of Agriculture, having been first elected delegate in 1879. For several years he served as the chairman of the executive committee of the Board, and was always a most faithful and useful member.. Resolutions of respect to his memory will be found in the records of the annual meeting.

Since the annual meeting of the Board Mr. D. A. Horton of Northampton has been appointed a member of the Board of Agriculture, in place of Hon. J. W. Stockwell of Sutton, whose term had expired.

WM. R. SESSIONS,
Secretary of the State Board of Agriculture.

Boston, February, 1892.

SPECIAL MEETINGS

OF THE

BOARD OF AGRICULTURE,

AT BOSTON.

April 28, December 2, 1891.

SPECIAL MEETINGS OF THE BOARD OF AGRICULTURE.

The Board met at the office of the secretary in Boston, Tuesday, April 28, 1891, at eleven o'clock A.M., having been called together, at the request of the Executive Committee, the Gypsy Moth Commission and the Governor, to consider an act of the Legislature to provide against the depredations of the insect known as the *Ocneria dispar* or gypsy moth, and to provide for the carrying out of the provisions of said act, and to consider the necessity of asking the Legislature for further appropriations therefor; to consider an act of the Legislature to authorize the State Board of Agriculture to collect and circulate information relating to abandoned farms, and to provide for the carrying out of the provisions of said act; to consider a resolve of the Legislature providing for an investigation by the State Board of Agriculture into the dangers to human life and health arising from tuberculosis in the food products of cattle, and to provide for carrying out the provisions of said resolve; and to consider and act upon the provisions of an act of the Legislature known as the "Dairy Commission Bill."

Present: Messrs. Alger, Appleton, J. G. Avery, Bancroft, Bowker, Bowditch, Clapp, Clemence, Cruickshanks, Cushman, Fernald, Fowler, Goessmann, Grinnell, Hayden, Hersey, Holbrook, Horton, Howe, Kilbourn, Mills, Newhall, Pratt, Rawson, Richards, Russell, Sargent, Shaler, Shaw, Stockwell, Varnum, Ware and Wood. Hon. James S. Grinnell was elected chairman.

The call for the meeting and the act of the Legislature in regard to the gypsy moth were read by the secretary. After remarks by Messrs. Shaler, Rawson and Fernald, it was voted, on motion of Mr. Bowditch, that the Chair appoint a committee of three, to nominate a committee of three to exercise all the duties and powers conferred upon the Board of Agriculture by House Bill, No. 228, entitled, "An Act to provide against depredations by the insect known as the *Ocneria dispar* or gypsy moth."

The Chair appointed as nominating committee Messrs. Bowditch, Cruickshanks and Mills.

The committee reported by their chairman, Mr. Bowditch, nominating the secretary, Wm. R. Sessions, Prof. N. S. Shaler and Francis H. Appleton as a committee to act for the Board, with full powers conferred upon the Board by the Legislature.

The report was accepted and adopted, and the said gentlemen were elected for the said purpose.

Voted, That the Massachusetts State Board of Agriculture petition the Legislature for the appropriation of fifty thousand dollars in addition to the amount left of former appropriations, the same to be used for continuing the work of the extermination of the *Ocneria dispar* or gypsy moth, and that the secretary be instructed to prepare, sign for the Board and transmit such a petition to the Governor, with the request that he present it to the Legislature in a special message.

Voted, On motion of Mr. Bowker, that the matter of abandoned farms be referred to the executive committee and the secretary, with full power to act for the Board in carrying out the provisions of any law that may be enacted by the Legislature in regard to the abandoned farms of Massachusetts.

Voted, On motion of Mr. Bowditch, that the committee on legislation be instructed to confer with the legislative committees on public health and agriculture, and express to them the opinion of this Board that a resolve like the one now before the Legislature, providing for an examination by the State Board of Agriculture to ascertain the best methods of protection against the dangers to human life and health arising from tuberculosis in the food products of cattle, known as Senate, No. 210, would not accomplish the desired result, by reason of insufficient appropriation and for the reason that the Board believes the Board of Health is the proper Board to undertake such investigation.

On motion of Mr. Stockwell, the following resolution was unanimously adopted: —

Resolved, That the Board of Agriculture congratulates the farmers of the State on the law passed by the present Legislature, "to prevent deception in the manufacture and sale of imitation butter;" to compel honesty in the sale of dairy products, and to protect from the fraudulent sale of imitations thereof.

Resolved, That the Board earnestly urges the Legislature to enact a bill for the better protection of dairy products, and to establish a dairy commission for the efficient enforcement of the above act and all other dairy laws, that the farmers may be insured the dairy market both at home and abroad by furnishing a pure product of best quality.

The Board then adjourned.

WM. R. SESSIONS,
Secretary.

A special meeting of the Board of Agriculture was held in the library of the Massachusetts Horticultural Society, Boston, Dec. 2, 1891, at five o'clock P.M. Hon. James S. Grinnell presided, and a majority of the members were present.

Voted, That Messrs. Grinnell, Bowditch and the secretary be added to the committee appointed at the last annual meeting of the Board, to whom was referred the essays read at the said annual meeting and printed in the "Agriculture of Massachusetts" for 1890; the full committee to consist of Messrs. Appleton, Wood, Hersey, Shaler, Bowker, Grinnell, Bowditch and the secretary.

Voted, That the same committee consider the suggestions of his Excellency the Governor for the greater efficiency and usefulness of the Board of Agriculture, and as to the representation of Massachusetts agriculture at the World's Columbian Exposition at Chicago. The committee was instructed to report at the annual meeting.

Adjourned. WM. R. SESSIONS,
Secretary.

At a meeting of the aforesaid committee on the World's Columbian Exposition, held immediately after the adjournment of the Board, it was

Voted, That the secretary be directed to communicate with the Department of Agriculture at Washington, and ascertain to what extent they propose to have the several States, especially Massachusetts (with a detail of the requirements from her), represented in their agricultural exhibit at the World's Columbian Exposition; and seek the earliest possible reply, in order that this Board, at its next annual meeting, Feb. 2, 1892, if deemed advisable, may ask for a suitable appropriation from the Legislature.

The reply received from Washington referred the committee to the Hon. W. I. Buchanan, Chief of the Department of Agriculture of the World's Columbian Exposition at Chicago, and information received from him showed that the matter was now under consideration by the Board of World's Fair Managers of Massachusetts after recent consultations with him.

MEETINGS OF THE EXECUTIVE COMMITTEE OF THE BOARD.

A meeting of the executive committee was held at the office of the secretary, Boston, Thursday, May 21, at eleven o'clock A.M.

Present: Messrs. Bowditch, Hersey, Hartshorn, Rawson and Varnum.

On petition of the Middlesex North Agricultural Society, it was voted that the said society be permitted to hold their next fair on Sept. 23, 24 and 25, 1891, instead of on the late assigned by the Board, which was September 29 and 30.

Voted, That on and after this year no society will be allowed to publish the date of its next succeeding fair until after the annual meeting of the Board, and that the secretary be instructed to inform each society of the adoption of this rule.

The resignation of N. S. Shaler, chairman of the examining committee of the Agricultural College, was received and accepted by the committee, and Mr. W. A. Kilbourn of South Lancaster was elected to fill the vacancy.

Voted, That the secretary be instructed to prepare a circular for transmission to the assessors of the several cities and towns of the Commonwealth, asking said assessors to return to the State Board of Agriculture, upon a blank prepared for that purpose, the names of the owners of abandoned or partially abandoned farms situated in the several cities and towns of the State; and that the secretary, by correspondence or otherwise, obtain descriptions of such farms as may be reported by the assessors, and collate and publish in pamphlet form the information so obtained.

A verbal communication was received from the Hingham Agricultural and Horticultural Society, through Mr. Hersey, requesting action by the Board looking to the collection and tabulation of analyses of the different crops raised in the State. Laid on the table.

Adjourned.

WM. R. SESSIONS,
Secretary.

A meeting of the executive committee was held at the office of the secretary, Boston, Saturday, August 29, at eleven o'clock A.M.

Present: Messrs. Bowditch, Hersey, Hartshorn and Rawson.

The meeting was called in part to consider the request of the Attleborough Agricultural Association for the approval of the Board to a mortgage of the property of the Association authorized by vote of the members on Aug. 8, 1891, said approval being necessary under chapter 274 of the Acts of 1890. A certified copy of the records of the meeting of the stockholders of the Association, at which they voted to mortgage the property of the Association for the sum of $7,500, was furnished the committee by the secretary of the Association, Mr. L. F. Mendell, who was present and answered questions. In accordance with the requirements of chapter 274, Acts of 1890, the executive committee duly advertised that a hearing would be given to interested parties; said advertisement appearing in the "Evening Chronicle," a newspaper published in North Attleborough, of the issue of Aug. 19, 1891. It appeared from the statement of the secretary that the proposed mortgage was for the purpose of securing the debt of the Association, incurred in the purchase of property owned by the Association and in erecting necessary buildings for the use of the Association.

It was voted to approve the mortgage of the Association's property to the amount of $7,500, and the secretary was instructed to notify the Association of this action.

The committee also considered the resolve of the Legislature of 1891, which instructed the Board of Agriculture to investigate and report to the next Legislature upon the best methods to be adopted to protect the citizens of this Commonwealth against the dangers to human life and health which may arise from the presence of tuberculosis in the food products of cattle. The matter was discussed, and the secretary was instructed to prepare a report and submit the same to a future meeting of the committee or of the full Board for consideration.

Adjourned. WM. R. SESSIONS,
Secretary.

PUBLIC WINTER MEETING

OF THE

BOARD OF AGRICULTURE,

AT BOSTON.

December 1, 2 and 3, 1891.

PUBLIC WINTER MEETING OF THE BOARD,

AT BOSTON.

The regular public winter meeting of the Massachusetts Board of Agriculture was held at Horticultural Hall, in Boston, on Tuesday, Wednesday and Thursday, Dec. 1, 2 and 3, 1891. The attendance at the opening session was exceptionally large, and among those present were very many of the most prominent and influential agriculturists in nearly every county of the State.

The meeting was called to order at ten o'clock on Tuesday, December 1, by Secretary SESSIONS, who said: —

I congratulate the Board upon the favorable auspices under which we meet. We meet in the city of Boston, the chief city of the Commonwealth, of which all Massachusetts citizens are proud. We meet in the hall of the Massachusetts Horticultural Society, a society which has a reputation not bounded by our continent, and of which all Massachusetts agriculturists and horticulturists are proud. We are honored by having our opening meeting presided over by the president of the Board, Governor RUSSELL, whom Massachusetts delights to honor.

Governor RUSSELL. Ladies and Gentlemen: My first duty as presiding officer of this Board is to assure the Board of the cordial welcome which I know the city of Boston extends to you, and to present one who will formally welcome you on behalf of the city. I regret to say that unavoidably the mayor of the city cannot be with us. He has, as perhaps you all know, very many duties which demand his time and attention, and he finds himself this morning under an imperative engagement which calls him elsewhere. He has, on very short notice, sent in his place the chairman of the Board of Aldermen, Alderman CARRUTH, well known to many of you, whom it gives me great pleasure to introduce.

ADDRESS OF ALDERMAN H. S. CARRUTH.

LADIES AND GENTLEMEN, MEMBERS OF THE STATE BOARD OF AGRICULTURE: — It certainly is a privilege and a personal pleasure to any gentleman speaking for the city of Boston to extend a hearty welcome to so important a body of men as the State Board of Agriculture of Massachusetts. Boston realizes fully the necessity for care, for intelligent scrutiny and investigation in this most important branch of human industry. There is, perhaps, a slight significance to be attached to my being designated to-day to extend to you the welcome of the city of Boston, as for several of the pleasantest periods of my life I had the pleasure and satisfaction of being a student in the Agricultural College at Amherst. There I learned to note and to appreciate at its full value this dignified calling, the earliest of civilized man, and through all the ages the most important. To-day in Massachusetts there are many incidents which perhaps may seem discouraging to those who follow this profession; but I believe that time has in store a solution of the difficulties which at present seem to weigh heavily upon the agricultural industry of our beloved State. I believe the time is not far distant when the burdens which rest upon it to-day will be lifted, and the agriculturist of Massachusetts will again have, as he has always had in the past, the proudest position among her citizens. Certainly the capital city of the Commonwealth cannot but appreciate the immense value to her of the thorough investigation which is to be carried on by this Board, and which I understand is the intent of this meeting to-day.

Again, there is a significance in my being asked to address you and to extend this welcome, being, as I am to-day, a representative in this hall of the second largest agricultural community in Massachusetts. Perhaps this statement will be a surprise to many people in the State; it nevertheless is a fact that in the value of her agricultural products the city of Boston is only exceeded by the city of Worcester in this Commonwealth. She stands second in the list of agricultural towns or cities, and in most other professions she stands at the head. Being the political capital and the commercial capital of the Commonwealth, she is most glad to have you present in her borders to-day as the representatives of this noble profession of agriculture.

I regret extremely that His Honor the Mayor could not have been present; but he is an extremely busy man, and I regret to say that at this juncture, when he is particularly occupied, sickness has invaded the office over which he presides, and has thrown upon his shoulders an amount of work wholly unexpected. He desired me to say to you that he deeply regretted his absence; that it would have been a great personal satisfaction to him to have been present, and to have extended to you, as its chief magistrate, a cordial welcome to the city.

Gentlemen, I trust that your deliberations will be most fruitful in results, and that this meeting will be followed by many others which the city of Boston will always be glad to have held within her borders.

ADDRESS OF HIS EXCELLENCY GOV. WM. E. RUSSELL.

Now, ladies and gentlemen, if you will permit me, I will introduce myself. I assure you it is a great pleasure to me to come as chairman of this Board to this meeting, and to express not only my personal good wishes to the Board, but also to bring with me the greeting of the Commonwealth, and express her great interest in the matters over which you have charge and in that great industry which has done so much to build up her strength and her prosperity. Though officially I am chairman of this Board, I do not mean to avail myself of the privilege of that position to inflict upon you a speech this morning, notwithstanding the formal announcement on your programme. Nor do I intend to touch upon those special subjects with which you deal, or to assume to have upon them any knowledge that is worthy of your attention and your consideration. I have come this morning, in the most informal way, to bring to you the greeting of the Commonwealth, and to assure you of the keen and constant interest she always has taken and always will take in agriculture, her entire confidence in the work that this Board has done, and her belief that it can assume even greater duties and responsibilities.

Massachusetts recognizes in agriculture not only her earliest industry, but one most important and necessary for her people, and one most closely interwoven with her whole life. From the very earliest days, when her children here in the midst of the wilderness first planted her soil, and while they struggled hard for a living, and with wonderful foresight and sacrifice founded her greatest and her most glorious institutions; from that time down through the later generations, when her agricultural community stood forth to defend her and her institutions and to struggle for her independence; and later still, within the recollection of many of us, in the days when from her fields and workshops went forth her children to fight for her as she fought for the nation and to stand with her for liberty and union, — down through all these periods Massachusetts has found in all her children, but especially in her farmers, loyalty and devotion to her institutions, and a courage and willingness to suffer and to fight for her and for them. So she recalls, too, that among her agricultural communities there is found simplicity of life, sturdiness of character, strength of purpose, and the many virtues that have done so much for her prosperity. She recalls that education and liberty, established and maintained through the church, the school-house and the town-meeting, have always marked the daily life among the farmers of this State. She knows that these are the virtues that have made a sturdy citizenship, and that in the strength and the character of that citizenship have been found her own strength and her own glory. Notwithstanding the magnitude of the many interests with which our Commonwealth deals, she always has exercised a fostering care of agriculture. She recognizes in this care not only the great value of agriculture to the State, but she expresses by it her gratitude for all that agriculture has done for her; not merely for her material prosperity, but for that greater prosperity, not measured by dollars and cents, but by character, and strong, loyal and law-abiding citizenship; that prosperity which has come from the work, from the virtues and the life especially of her agricultural people. So, with a desire to foster agriculture, she has created this great Board of Agriculture which meets here to-day. She has entrusted to it important duties and powers. With generous appropriations, she has done something too for those important agricultural societies which the members of this Board represent, and through them has sought in every community to encourage agriculture. She has sought to make her farmers, in a spirit of friendly rivalry, do their best, and by their labor, their ability, their skill and patience, overcome whatever hard conditions nature has imposed upon their industry. So, too, constantly by wise and wholesome laws she has guarded agriculture against the evils that have beset it, and striven to do all in her power to promote the interests of her farmers.

But I find I am rapidly drifting into a speech. I doubt if this Board knew the risk they were running when they invited me to speak to them. Perhaps they forgot that but a little time has elapsed since I was in the active business of speech-making, and that it only requires the slightest provocation for me to drift back to my old work and weary your patience and perhaps violate the generous courtesy that you have extended to me. So I think I ought to end my welcome here. But before doing so I wish to make two suggestions to this Board. I do not profess that knowledge of agriculture which would permit me to deal with the matters that come immediately under your supervision; but, from my official knowledge of the work of this Board and of the character and ability that are here represented, and from what I have learned of its work and its membership, I am one who firmly believes that greater power and greater responsibility should be placed upon the Board of Agriculture of Massachusetts. I believe that this Board comes closely in touch with the agricultural interests. Of course I know that each member of the Board has a personal interest in that industry, but beyond that they represent those great societies which come in touch with our agricultural communities. I have felt throughout the year that there was open to this Board by a determined effort a great opportunity to do even more for agriculture. I believe that greater executive powers should be given to this Board and be exercised by it. I believe that this Board should become not merely a meeting of members to discuss the special topics in which you are all interested, — though I know that such discussion is most profitable and valuable, — but I believe that it should assume and take charge of the agricultural interests so far as the State is connected with them and is to have any influence over them. I have shown my belief during the year by certain recommendations in that direction. As you know, I recommended a transfer to this Board of the duties of one commission, and I believe that great good has come from that transfer. That was purely executive work. I also most strongly urged, when the law was under discussion for the creation of a dairy bureau, — a most wise and necessary law, as it seems to me, — I urged that that bureau should be created out of the Board of Agriculture, and that its work and its duties should be under the supervision of this important Board. I think that you might well consider during your deliberations, either at this meeting or at some later meeting, whether there are not other duties, exercised perhaps now by other bodies in this Commonwealth, which might well come under the supervision of the Board of Agriculture, and their appropriations and their salaries be transferred to this Board, and bureaus here created, either with or without salaries, as seems best, for doing the executive work that is important to agriculture. It seems to me that the value of that would be that this great Board would stand responsible for the execution and enforcement of the laws in which you are specially and vitally interested; that there would be one great, important central body, divided into bureaus, to be sure, but exercising constant supervision over the work of these bureaus; that there would be this one great central Board closely in touch with agriculture, that would stand responsible for the enforcement of laws in which agriculture is interested; and then it would come with great influence and weight to any Legislature with suggestions for the improvement of those laws or for the making of new ones.

One other suggestion, and I have finished. You all know that soon we are to have a World's Fair. I am sure you know the great interest our Commonwealth takes in that fair. Whatever difference of opinion may have existed in the past over the minor question of where the fair should be held, I am certain that the people of this Commonwealth are unanimous in their loyalty to the fair, and their determination that it shall be a success, and that Massachusetts at that fair shall be creditably and honorably represented. I do not believe that Massachusetts is going to fail to make a generous appropriation, and to do all that may be necessary to make her exhibit a creditable one. Far more important is it that Massachusetts should show there all that she has, — and she has more, I believe, than any State in the Union to show, — far more important is it that she should make a worthy and honorable exhibit, than that she should save a few dollars or a few thousands of dollars in the expense. Now, among the many things in which Massachusetts is interested, agriculture stands forth as one of the most important. It seems to me that I cannot urge upon you too strongly the importance of this Board considering what sort of an exhibit the agricultural interests of Massachusetts shall make at that World's Fair. As you may know, it was my pleasure to appoint on our commission one member who I believe distinctly represents the agricultural interests of the State. I know that all that he can do will be done to have a worthy exhibit; but still I feel that the power lies with this Board of determining how successful that exhibit shall be, and I can conceive of no more important work that this Board can do than either now or at some later meeting carefully and methodically to consider what the exhibit shall be, and make plans to see that your ideas are carried out. I know that any suggestions you may have to make will come with great weight to the Legislature, if action by that body is necessary; and I am sure they will come with greater weight still to the World's Fair Commission, who are only too anxious to enlist the support of bodies like this in helping them in their work.

And now, Mr. Secretary, I have trespassed quite long enough on the time of this Board. Let me close as I began, by extending to you not only my personal good wishes, but the heartiest welcome of the old Commonwealth, and her earnest desire that this meeting may result in great good to agriculture, and so in great good to her.

Now, gentlemen, perhaps you know that the Governor of the Commonwealth also has considerable work on his shoulders. I would not dare to tell you in detail how much that work is; it is enough for me now to say that it takes me away, and with great regret, at this early hour, from your meeting. I shall, I hope, be with you at some of your meetings during your three days' session. I will call to the chair, to preside in my absence, Mr. E. W. WOOD of West Newton.

Mr. WOOD took the chair.

The CHAIRMAN. The subject selected for this forenoon meeting is "The Crossing of Plants." To this we are indebted for the improvements made in our fruits, our flowers and our vegetables, to a very large extent. Formerly we were dependent almost entirely upon the work of bees and other insects. They were not particular about selecting the pollen from any special plant for fertilizing, and in recent years more attention has been paid to this particular subject. We have been fortunate in securing to speak upon this question one who has made a specialty of this department of science. I have the pleasure of introducing to the audience Professor BAILEY of Cornell University.

THE PHILOSOPHY OF THE CROSSING OF PLANTS,

CONSIDERED IN

REFERENCE TO THEIR IMPROVEMENT UNDER CULTIVATION.

BY PROF. L. H. BAILEY, ITHACA, N. Y.

It is now understood that the specific forms or groups of plants have been determined largely by the survival of the fittest in a long and severe struggle for existence. The proof that this struggle everywhere exists becomes evident upon a moment's reflection. We know that all organisms are eminently variable. In fact, no two plants or animals in the world are exactly alike. We also know that very few of the whole number of seeds which are produced in any area ever grow into plants. If all the seeds produced by the elms upon Boston Common in any fruitful year were to grow into trees, this city would become a forest as a result. If all the seeds of the rarest orchid in our woods were to grow, in a few generations of plants even our farms would be overrun. If all the rabbits which are born were to reach old age, and all their offspring were to do the same, in less than ten years every vestige of herbage would be swept from the country, and our farms would become barren. There is, then, a wonderful latent potency in these species; but the same may be said of every species of plant and animal, even of man himself. If one species of plant would overrun and usurp the land if it increased to the full extent of its possibilities, what would be the result if each of the two thousand and sixty-one plants known to inhabit Middlesex County were to do the same? And then fancy the result if each of the animals, from rabbits and mice to frogs and leeches, were to increase without check! The plagues of Egypt would be insignificant in the comparison! The fact is, the world is not big enough to hold the possible first offspring of the plants and animals at this moment living upon it. Struggle for existence, then, is inevitable, and it must be severe. It follows as a necessity that those seeds grow or those plants live which are best fitted to grow and live, or which are fortunate enough to find a congenial foothold. It would appear at first that much depends upon the accident of falling into a congenial place, or one unoccupied by other plants or animals; but, inasmuch as scores of plants are contending for every unoccupied place, it follows that everywhere only the fittest can germinate or grow. In the great majority of cases, plants grow in a certain place because they are better fitted to grow there, to hold their own, than any other plants are; and the instances are rare in which a plant is so fortunate as to find an unoccupied place. We are apt to think that plants chance to grow where we find them, but the chance is determined by law, and therefore is not chance.

Much of the capability of a plant to persist under all this struggle depends, therefore, upon how much it varies; for the more it varies the more likely it is to find places of least struggle. It grows under various conditions, — in sun and shade, in sand and clay, by the sea-shore or upon the hills, in the humidity of the forest or the aridity of the plains. In some directions it very likely finds less struggle than in others, and in these directions it expands itself, multiplies, and gradually dies out in other directions. So it happens that it tends to take on new forms or to undergo an evolution. In the mean time, all the intermediate forms, which are at best only indifferently adapted to their conditions, tend to disappear. In other words, gaps appear which we call "missing links." The weak links break and fall away, and what was once a chain becomes a series of rings. So the "missing links" are among the best proofs of evolution.

The question now arises as to the cause of these numerous variations in animals and plants. Why are no two individuals in nature exactly alike? The question is exceedingly difficult to answer. It was once said that plants vary because it is their nature to vary; that variation is a necessary function, as much as growth or fructification. This really removes the question beyond the reach of philosophy; and direct observation leads us to think that some variation, at least, is due to external circumstances. We are now looking for the cause of variation along some of the lines of evolution; and we are wondering if the varied surroundings, or, as Darwin put it, the "changed conditions of life," may not actually induce variability. This conclusion would seem to follow to some extent, from the fact of the severe and universal struggle in nature whereby plants are constantly forced into new and strange conditions. But there is undoubtedly much variation which has sprung from more remote causes, one of which it is my purpose to discuss here.

In the lowest animals and plants the species multiplies by means of simple division or by budding. One individual, of itself, becomes two, and the two are therefore re-casts of the one. But, as organisms multiplied and conditions became more complex, that is, as struggle increased, there came a differentiation in the parts of the individual, so that one cell or one cluster of cells performed one labor and other cells performed other labor; and this tendency resulted in the development of organs. Simple division, therefore, could no longer reproduce the whole complex individual; and, as all organs are necessary to the existence of life, the organism dies if it is divided. Along with this specialization came the differentiation into sex; and sex clearly has two offices: to hand over, by some mysterious process, the complex organization of the parent to the offspring, and also to unite the essential characters or tendencies of two beings into one. The second office is manifestly the greater; for, as it unites two organizations into one, it insures that the offspring is somewhat unlike either parent, and is therefore better fitted to seize upon any place or condition new to its kind. And, as the generations increase, the tendency to variation in the offspring must be constantly greater, because the impressions of a greater number of ancestors are transmitted to it. I have said that this office of sex to induce variation is more important than the mere fact of reproduction of a complex organization; for it must be borne in mind that the complexity of organization is itself a variation, made necessary by the increasing struggle for existence.

If, therefore, the philosophy of sex is to promote variation by the union of different individuals, it must follow that greatest variation must come from parents considerably unlike each other in their minor characters. Thus it comes that in-breeding tends to weaken a type, and cross-breeding tends to strengthen it. And at this point we meet the particular subject which I am to present to you. I have introduced you to this preliminary sketch because I contend that we can understand crossing only as we make it a part of the general philosophy of nature. There are the vaguest notions concerning the possibilities of crossing, some of which I hope to correct by presenting the subject in its relations to the general aspects of the vegetable world.

We are now prepared to understand that crossing is good for the species, because it constantly revitalizes offspring with the strongest traits of the parents, and presents ever-new combinations which enable the individuals to stand a better chance of securing a place in the polity of nature. All the further discussions of the subject are such as have to do with the extent to which crossing is possible and advisable, and the mere methods of performing the operation.

At this point I must digress, for the purpose of defining certain terms which it is necessary to use frequently. I use the term *cross* to denote the offspring of any sexual union between plants, whether of different species or varieties, or even different flowers upon the same plant. It is a general term. And the word is also sometimes used to denote the operation of performing or bringing about the sexual union. There are different kinds of crosses. One of these is the *hybrid*. A hybrid is a cross between two species, as a plum and a peach, or a raspberry and a blackberry. There has lately been some objection urged against this term, because it is often impossible to define the limitations of species, — to tell where one species ends and another begins. And it is a fact that this difficulty exists, for plants which some botanists regard as mere varieties others regard as distinct species. But the term hybrid is no more inaccurate than the term species, upon which it rests; and, so long as men talk about species, so long have we an equal right to talk about hybrids. Here, as everywhere, terms are mere conveniences, and they seldom express the whole truth. In common speech the word hybrid is much misused. Crosses between varieties of one species are termed *half-breeds* or *cross-breeds*, and those between different flowers upon the same plant are called *individual crosses.*

If crossing is good for the species, which philosophy and direct experiment abundantly show, it is necessary at once to find out to what extent it can be carried. Does the good increase in proportion as the cross becomes more violent, or as the parents are more and more unlike? Or do we soon find a limit beyond which it is not profitable or even possible to go, — a point at which we say that "an inch is as good as an ell"? If great variability is good for the species in the struggle for existence, and if crossing induces variability because of the union of unlike individuals, it would seem to follow that the more unlike the parents are the greater will be the variation in offspring and the more the species would prosper; and, carrying this thought to its logical conclusion, we should expect to find that the most closely related plants would constantly tend to refuse to cross, because the offspring of them would be little variable and therefore little adapted to the struggle for existence; while the most widely separated plants would constantly tend to cross more and more, because their offspring would present the greatest possible degrees of differences. We should expect, for instance, that a Baldwin apple would be less likely to cross with a Greening than it is to cross with a peach or a pear. And, if we should carry our thought a step farther, we should at once see that this crossing between different species would soon fill in all differences between those species, and that definite specific types would cease to exist. This would be pandemonium, and crossing would be the cause of it.

Now, essentially this reasoning has been advanced to combat the evolution of plants and animals by means of natural selection; and this proposition that intermixing must constantly tend to obliterate all differences between plants and to prevent the establishment of well-marked types, has been called the "swamping effects of intercrossing." It is exceedingly important that we consider this question, for it really lies at the foundation of the improvement of cultivated plants by means of crossing, as well as the persistence and evolution of varieties and species under wholly natural conditions.

We find, however, that distinct species, as a rule, refuse to cross; and the first question which naturally arises is, What is the immediate cause of the refusal of plants to cross? How does this refusal express itself? It comes about in many ways. The commonest cause is the positive refusal of a plant to allow its ovules to be impregnated by the pollen of another plant. The pollen will not "take." For instance, if we apply the pollen of a Hubbard squash to the flower of the common field pumpkin, there will simply be no result, — the fruit will not form. The same is true of the pear and the apple, the oat and the wheat, and most very unlike species. Or the refusal may come in the sterility of the cross or hybrid. The pollen may "take" and seeds may be formed and the seeds may grow, but the plants which they produce may be wholly barren, sometimes even refusing to produce flowers as well as seeds, as in the instance of some hybrids between the wild-goose plum and the peach. Sometimes the refusal to cross is due to some difference in the time of blooming or some incompatibility in the structure of the flowers. But it is enough for our purpose to know that there are certain characters in widely dissimilar plants which prevent intercrossing, and that these characters are just as positive and just as much influenced by change of environment and natural selection as are size, color, productiveness and other characters. Here, then, is the sufficient answer to the proposition that intercrossing must swamp all natural selection, and also the explanation of the varying and often restricted limits within which crossing is possible. That is, the checks to crossing have been developed through the principle of universal variability and natural selection, as has been shown by Darwin and Wallace. Plants vary in their reproductive organs and powers just the same as they do in other directions; and when such a variation is useful it is perpetuated, and when hurtful it is lost. Suppose that a certain well-marked individual of a species should find an unusually good place in nature, and it should multiply rapidly.

Crosses would be made between its own offspring and perhaps between those offspring and itself in succeeding years; and it is fair to suppose that some of the crosses would be particularly well adapted to the conditions in which the parent grew, and these would constantly tend to perpetuate themselves, while less adaptive forms would constantly tend to disappear. Now, the same thing would take place if this individual or its adaptive offspring were to cross with the main stock of the parent species; for all the offspring of such a cross which are intermediate in character and therefore less adapted to the new conditions would tend to disappear, and the two branches would, as a result, become more and more fixed, and the tendency to cross would constantly decrease. The refusal to cross, therefore, becomes a positive character of separation, and the "missing links" which resulted from crossing are no more or no less inexplicable than the "missing links" due to simple selection; or, to put the case more accurately, natural selection weeds out the tendency to promiscuous crossing, when it is hurtful, in just the same manner that it weeds out any other injurious tendency. It makes no difference in what way this tendency expresses itself; whether in some constitutional refusal to cross, — if such exists, — or in infertility of offspring, or in different times of blooming, — all equally come under the power of natural selection. We are apt to look upon infertility as the absence of a character, a sort of a negative feature which is somehow not the legitimate property of natural selection; but such is not the case. We are perhaps led the more to this feeling because the word infertility is itself negative, and because we associate full productiveness with the positive attributes of plants. But loss of productiveness is surely no more a subject of wonder than loss of color or size, if there is some corresponding gain to be accomplished. In fact, we see, in numerous plants which propagate easily by means of runners and suckers, a very low degree of productiveness.

Now, if this reasoning is sound, it leads us to conclusions quite the reverse of those held by the advocates of the swamping effects of intercrossing, and these conclusions are of the most vital importance to every man who tills the soil.

The logical result is simply this: the best results of crossing are obtained, as a rule, when the cross is made between different individuals of the same variety, or at farthest, between different individuals of the same species. In other words, hybrids — or crosses between species — are rarely useful, and it follows as a logical result that the more unlike the species the less useful will be the hybrids. This, I am aware, is counter to the notions of most horticulturists, and, if true, must entirely overthrow our common thinking upon this subject. But I think that I shall be able to show that observation and experiment lead to the same conclusion to which our philosophy has brought us.

At this point we must ask ourselves what we mean by "best results." I take this phrase to refer to those plants which are best fitted to survive in the struggle for existence, those which are most vigorous or most productive or most hardy, or which possess any well-marked character or characters which distinguish them in virility from their fellows. We commonly associate the term more particularly with the marked vigor and productiveness; these are the characters most useful in nature and also in cultivation, the ones which we oftenest desire to obtain. Another type of variation which we constantly covet is something which we can call a new character which will lead to the production of a new cultural variety, and we are always looking to this as the legitimate result of crossing. We have forgotten — if, indeed, we ever knew — that the commoner, all-pervading, more important function of the cross is to infuse some new strength or power into the offspring, to improve or to perpetuate an existing variety, rather than to create a new one. Or, if a new one is created, it comes from the gradual passing of one into another, an inferior variety into a good one, a good one into a superlative one. So nature employs crossing in a process of slow or gradual improvement, one step leading to another, and not in any bold or sudden creation of new forms. And there is evidence to show that something akin to this must be done to secure the best and most permanent results under cultivation. The notion is somehow firmly rooted in the popular mind that new varieties can be produced with the greatest ease by crossing parents of given attributes. There is something captivating about the notion. It smacks of a somewhat magic power which man evokes as he passes his wand over the untamed forces of nature. But the wand is often only a gilded stick, and is apt to serve no better purpose than the drum major's pretentious baton.

Let me say further that crossing alone can accomplish comparatively little. The chief power in the evolution or progression of plants appears to be selection, or, as Darwin puts it, the law of "preservation of favorable individual differences and variations, and the destruction of those which are injurious." Selection is the force which augments, develops and fixes types. Man must not only practice a judicious selection of parents from which the cross is to come, which is in reality but the exercise of a choice, but he must constantly select the best from among the crosses, in order to maintain a high degree of usefulness and to make any advancement; and it sometimes happens that the selection is much more important to the cultivator than the crossing. I do not wish to discourage the crossing of plants, but I do desire to dispel the charm which too often hangs about it.

Further discussion of this subject naturally falls under two heads: the improvement of existing types or varieties by means of crossing, and the summary production of new varieties. I have already stated that the former office is the more important one, and the proposition is easy of proof. It is the chief use which nature makes of crossing,—to strengthen the type. Think, for instance, of the great rarity of hybrids or pronounced crosses in nature. No doubt all the authentic cases on record could be entered in one or two volumes, but a list of all the individual plants of the world could not be compressed into ten thousand volumes. There are a few genera, in which the species are not well defined or in which some character of inflorescence favors promiscuous crossing, in which hybrids are conspicuous; but even here the number of individual hybrids is very small in comparison to the whole number of individuals. That is, the hybrids are rare, while the parents may be common. This is well illustrated even in the willows and oaks, in which, perhaps, hybrids are better known than in any other American plants. The great genus carex or sedge, which occurs in great numbers and many species in almost every locality in New England, and in which the species are particularly adapted to intercrossing by the character of their inflorescence, furnishes but few undoubted hybrids. Among one hundred and sixty-seven species and prominent varieties inhabiting the north-eastern States, there are only nine hybrids recorded, and all of them are rare or local, some of them having been collected but once. Species of remarkable similarity may grow side by side for years, even intertangled in the same clump, and yet produce no hybrid. These instances prove that nature avoids hybridization, — a conclusion at which we have already arrived from philosophical considerations. And we have reason to infer the same conclusion from the fact that flowers of different species are so constructed as not to invite intercrossing. But, on the other hand, the fact that all higher plants habitually propagate by means of seeds, which is far the most expensive to the plant of all methods of propagation, while at the same time most flowers are so constructed as to prevent self-fertilization, proves that some corresponding good must come from crossing within the limits of the species or variety; and there are purely philosophical reasons, as we have seen, which warrant a similar conclusion. But experiment has given us more direct proof of our propositions, and we shall now turn our attention to the garden.

Darwin was the first to show that crossing within the limits of the species or variety results in a constant revitalizing of the offspring, and that this is the particular ultimate function of the operation. Kœlreuter, Sprengel, Knight and others, had observed many, if, indeed, not all, the facts obtained by Darwin; but they had not generalized upon them broadly, and did not conceive their relation to the complex life of the vegetable world. Darwin's results are, concisely, these: self-fertilization tends to weaken the offspring; crossing between different plants of the same variety gives stronger and more productive offspring than arises from self-fertilization; crossing between stocks of the same variety grown in different places or under different conditions gives better offspring than crossing between different plants grown in the same place or under similar conditions; and his researches have also shown that, as a rule, flowers are so constructed as to favor cross-fertilization. In short, he found, as he expressed it, that "nature abhors perpetual self-fertilization." Some of his particular results, although often quoted, will be useful in fixing these facts in our minds. Plants from crossed seeds of morning-glory exceeded in height those from self-fertilized seeds as 100 exceeds 76, in the first generation. Some flowers from these plants were self-pollinated and some were crossed, and in this second generation the crossed plants were to the uncrossed as 100 is to 79; the operation was again repeated, and in the third generation the figures stand 100 to 68; fourth generation, the plants having been grown in midwinter, when none of them did well, 100 to 86; fifth generation, 100 to 75; sixth generation, 100 to 72; seventh generation, 100 to 81; eighth generation, 100 to 85; ninth generation, 100 to 79; tenth generation, 100 to 54. The average total gain in height of the crossed over the uncrossed was as 100 to 77, or about 30 per cent. There was a corresponding gain in fertility, or the number of seeds and seed-pods produced. Yet, as striking as these results are, they were produced by simply crossing between plants grown near together, and under what would ordinarily be called uniform conditions. In order to determine the influence of crossing with fresh stock, plants of the same variety were obtained from another garden, and these were crossed with the ninth generation mentioned above. The offspring of this cross exceeded those of the other crossed plants as 100 exceeds 78, in height; as 100 exceeds 57, in the number of seed-pods; and as 100 exceeds 51, in the weight of the seed-pods. In other words, crosses between fresh stock of the same variety were nearly 30 per cent more vigorous than crosses between plants grown side by side for some time, and over 44 per cent more vigorous than plants from self-fertilized seeds. On the other hand, experiments showed that crosses between different flowers upon the same plant gave actually poorer results than offspring of self-fertilized flowers. It is evident, from all these figures, that nature desires crosses between plants, and, if possible, between plants grown under somewhat different conditions. All the results are exceedingly interesting and important; and there is every reason to believe that, as a rule, similar results can be obtained with all plants.

Darwin extended his investigations to many plants, only a few of which need be discussed here. Cabbage gave pronounced results. Crossed plants were to self-fertilized plants in weight as 100 is to 37. A cross was now made between these crossed plants and a plant of the same variety from another garden, and the difference in weight of the resulting offspring was the difference between 100 and 22, showing a gain of over 350 per cent, due to a cross with fresh stock. Crossed lettuce plants exceeded uncrossed in height as 100 exceeds 82. Buckwheat gave an increase in weight of seeds as 100 to 82, and in height of plants as 100 to 69. Beets gave an increase in height represented by 100 and 87. Maize, when full grown, from crossed and uncrossed seeds, gave the differences in height between 100 and 91. Canary-grass gave similar results.

I have obtained results as well marked as these upon a large and what might be called a commercial scale. I raised the plants during the first generation of seeds from known parentage, the flowers from which they came having been carefully pollinated by hand. In some instances the second generations were grown from hand-crossed seeds, but in other cases the second generations were grown from seeds simply selected from the first-year patches. As the experiments have been made in the field and upon a somewhat extensive scale, it was not possible to accurately measure the plants and the fruits from individuals in all cases; but the results have been so marked as to admit of no doubt as to their character. In 1889 several hand-crosses were made among egg-plants. Three fruits matured, and the seeds from them were grown in 1890. Some two hundred plants were grown, and they were characterized throughout the season by great sturdiness and vigor of growth. They grew more erect and taller than other plants near by grown from commercial seeds. They were the finest plants which I had ever seen. It was impossible to determine productiveness, from the fact that our seasons are too short for egg-plants, and only the earliest flowers, in the large varieties, perfect their fruit, and the plant blooms continuously through the season. In order to determine how much a plant will bear, it must be grown until it ceases to bloom. When frost came, I could see little difference in productiveness between these crossed plants and commercial plants. A dozen fruits were selected from various parts of this patch, and in 1891 about twenty-five hundred plants were grown from them. Again the plants were remarkably robust and healthy, with fine foliage, and they grew erect and tall, — an indication of vigor. They were also very productive; but, as the cross had been made between unlike varieties, and they were therefore unlike either parent, I could not make an accurate comparison. But they compared well with commercial egg-plants, and I am satisfied that they would have shown themselves to be more productive than common stock could they have grown a month or six weeks longer. Professor Munson, of the Maine Agricultural College, grew some of this crossed stock this year (1891), and he writes me that it is better than any commercial stock in his gardens.

In extended experiments in the crossing of pumpkins, squashes and gourds, carried on during several years, increase in productiveness due to crossing has been marked in many instances. Marked increase in productiveness has been obtained from tomato crosses, even when no other results of crossing could be seen.

Bearing in mind these good influences of crossing, let us recall another series of facts following the simple change of seed. Almost every farmer and gardener at the present day feels that an occasional change of seed results in better crops, and there are definite records to show that such is often the case. In fact, I am convinced that much of the rapid improvement in fruits and vegetables in recent years is due to the practice of buying plants and seeds so largely of dealers, by means of which the stock is often changed. Even a slight change, as between farms or neighboring villages, sometimes produces marked results, such as more vigorous plants and often more fruitful ones. We must not suppose, however, that because a small change gives a good result a violent or very pronounced change gives a better one. There are many facts on record to show that great changes often profoundly influence plants, and when such influence results in lessened vigor or lessened productiveness we call it an injurious one. Now, this injurious influence may result even when all the conditions in the new place are favorable to the health and development of the plant; it is an influence which is wholly independent, so far as we can see, of any condition which interferes injuriously with the simple processes of growth. Seeds of a native physalis or husk-tomato were sent to me from Paraguay in 1889 by Dr. Thomas Morong, then travelling in that country. I grew it both in the house and out of doors, and for two generations was unable to make it set fruit, even though the flowers were hand-pollinated; yet the plants were healthy and grew vigorously. The third generation grown out of doors this year set fruit freely. This is an instance of the fact that very great changes of conditions may injuriously affect the plant, and an equally good illustration of the power to overcome these conditions. Now, there is great similarity between the effects of slight and violent changes of conditions and small and violent degrees of crossing, as both Darwin and Wallace have pointed out; and it is pertinent to this discussion to endeavor to discover if there is any real connection between the two.

It is well proved that crossing is good for the resulting offspring, because the differences between the parents carry over new combinations of characters or at least new powers into the crosses. It is a process of revitalization, and, the more different the stocks in desirable characters within the limits of the variety, the greater is the revitalization; and frequently the good is of a more positive kind, resulting in pronounced characters which may serve as the basis for new varieties. In the cross, therefore, a new combination of characters or a new power fit it to live better than its parents in the conditions under which they lived. In the case of change of stock we find just the reverse, which, however, amounts to the same thing, — that the same characters or powers fit the plant to live better in conditions new to it than plants which have long lived in those conditions. In either case, the good comes from the fitting together of new characters or powers and new environments. Plants which live during many generations in one place become accustomed to the place, thoroughly fitted into its conditions, and are in what Mr. Spencer calls a state of equilibrium. When either plant or conditions change, new adjustments must take place; and the plant may find an opportunity to take advantage, to expand in some direction in which it has before been held back, — for plants always possess greater power than they are able to express. "These rhythmical actions or functions (of the organism)," writes Spencer, "and the various compound rhythms resulting from their combinations, are in such adjustment as to balance the actions to which the organism is subject; there is a constant or periodic genesis of forces which, in their kinds, amounts and directions, suffice to antagonize the forces which the organism has constantly or periodically to bear. If, then, there exists this state of moving equilibrium among a definite set of internal actions, exposed to a definite set of external actions, what must result if any of the external actions are changed? Of course there is no longer an equilibrium. Some force which the organism habitually generates is too great or too small to balance some incident force; and there arises a residuary force exerted by the environment on the organism, or by the organism on the environment. This residuary force, this unbalanced force, of necessity expends itself in producing some change of state in the organism." The good results, therefore, are processes of adaptation, and when adaptation is perfectly complete the plant may have gained no permanent advantage over its former condition, and new crossing or another change may be necessary; yet there is often a permanent gain, as when a plant becomes visibly modified by change to another climate. Now, this adaptive change may express itself in two ways: either by some direct influence upon the stature, vigor or other general character, or indirectly upon the reproductive powers, by which some new influence is carried to the offspring. If the direct influences become hereditary, as observation seems to show may sometimes occur, the two directions of modification may amount, ultimately, to the same thing.

For the purposes of this discussion it is enough to know that crossing within the variety and change of stock within ordinary bounds are beneficial, that the results in the two cases seem to flow from essentially the same causes, and that crossing and change of stock combined give much better results than either one alone. These processes are much more important than any mere groping after new varieties, as I have already said; not only because they are surer, but because they are universal and necessary means of maintaining and improving both wild and cultivated plants. Even after one succeeds in securing and fixing a new variety, he must employ these means to a greater or less extent to maintain fertility and vigor. In the case of some garden crops, in which many seeds are produced in each fruit and in which the operation of pollination is easy, actual hand-crossing from new stock now and then may be found to be profitable. But in most cases the operation can be left to nature, if the new stock is planted among the old. Upon this point Darwin expressed himself as follows: "It is a common practice with horticulturists to obtain seeds from another place having a very different soil, so as to avoid raising plants for a long succession of generations under the same conditions; but with all the species which freely intercross by the aid of insects or the wind, it would be an incomparably better plan to obtain seeds of the required variety, which had been raised for some generations under as different conditions as possible, and sow them in alternate rows with seeds matured in the old garden. The two stocks would then intercross, with a thorough blending of their whole organizations, and with no loss of purity to the variety; and this would yield far more favorable results than a mere change of seeds."

But you are waiting for a discussion of the second of the great features of crossing, — the summary production of new varieties. This is the subject which is almost universally associated with crossing in the popular mind, and even among horticulturists themselves. It is the commonest notion that the desirable characters of given parents can be definitely combined in a pronounced cross or hybrid. There are two or three philosophical reasons which somewhat oppose this doctrine, and which we will do well to consider at the outset. In the first place, nature is opposed to hybrids, for species have been bred away from each other in the ability to cross. If, therefore, there is no advantage for nature to hybridize, we may suppose that there would be little advantage for man to do so; and there would be no advantage for man did he not place the plant under conditions different from nature, or desire a different set of characters. We have seen that nature's chief barriers to hybridization are total refusal of species to unite, and entire or comparative seedlessness of offspring. We can overcome the refusal to cross in many cases by bringing the plant under cultivation; for the character of the species becomes so changed by the wholly new conditions that its former antipathies may be overpowered. Yet it is doubtful if such a plant will ever acquire a complete willingness to cross. In like manner we can overcome in a measure the comparative seedlessness of hybrids, but it is very doubtful if we can ever make such hybrids completely fruitful. It would appear, therefore, upon theoretical grounds, that in plants in which fruits or seeds are the parts sought, no good can be expected, as a rule, from hybridization; and this seems to be affirmed by facts. It is evident that species which have been differentiated or bred away from each other in a given locality will have more opposed qualities or powers than similar species which have arisen quite independently in places remote from each other. In the one case the species have likely struggled with each other until each one has attained to a degree of divergence which allows it to persist; while in the other case there has been no struggle between the species, but similar conditions have brought about similar results. These similar species which appear independently of each other in different places are called representative species. Islands remote from each other but similarly situated with reference to climate very often contain representative species; and the same may be said of other regions much like each other, as eastern North America and Japan. Now, it follows that, if representative species are less opposed than others, they are more likely to hybridize with good results; and this fact is remarkably well illustrated in the Kieffer and allied pears, which are hybrids between representative species of Europe and Japan; and I am inclined to think that the same may be found to be true of the common or European apple and the wild crab of the Mississippi valley. Various crabs of the Soulard type, which I once thought to constitute a distinct species, appear upon further study to be hybrids. We will also recall that the hybrid grapes which have so far proved most valuable are those obtained by Rogers between the American *Vitis Labrusca* and the European wine grape; and that the attempts of Haskell and others to hybridize associated species of native grapes have given, at best, only indifferent results. To these good results from hybrids of fruit trees and vines I shall revert presently.

Another theoretical point, which is borne out by practice, is the conclusion that, because of the great differences and lack of affinity between parents, pronounced hybrid offspring are unstable. This is one of the greatest difficulties in the way of the summary production of new varieties by means of hybridization. It would appear, also, that, because of the unlikeness of parents, hybrid offspring must be exceedingly variable; but, as a matter of fact, in many instances the parents are so pronouncedly different that the hybrids represent a distinct type by themselves, or else they approach very nearly to the characters of one of the parents. There are, to be sure, many instances of exceedingly variable hybrid offspring, but they are usually the offspring of variable parents. In other words, variability in offspring appears to follow rather as a result of variability in parents than as a result of mere unlikeness of characters. But the instability of hybrid offspring when propagated by seed is notorious. Wallace writes that "the effect of occasional crosses often results in a great amount of variation, but it also leads to instability of character, and is therefore very little employed in the production of fixed and well-marked races." I may remark again that, because of the unequal and unknown powers of the parents, we can never predict what characters will appear in the hybrids. This fact was well expressed by Lindley a half century ago, in the phrase, "Hybridizing is a game of chance played between man and plants."

Bearing these fundamental propositions in mind, let us pursue the subject somewhat in detail. We shall find at the outset that the characters of hybrids, as compared with the characters of simple crosses between stocks of the same variety, are ambiguous, negative, and often prejudicial. The fullest discussion of hybrids has been made by Focke, and he lays down the five following propositions concerning the character of hybrid offspring: —

1. "All individuals which have come from the crossing of two pure species or races, when produced and grown under like conditions, are usually exactly like each other, or at least scarcely more different from each other than plants of the same species are." This proposition, although perhaps true in the main, appears to be too broadly and positively stated.

2. "The characters of hybrids are different from the characters of the parents. The hybrids differ most in size and vigor and in their sexual powers."

3. "Hybrids are distinguished from their parents by their powers of vegetation or growth. Hybrids between very different species are often weak, especially when young, so that it is difficult to raise them. On the other hand, cross-breeds are, as a rule, uncommonly vigorous; they are distinguished mostly by size, rapidity of growth, early flowering, productiveness, longer life, stronger reproductive power, unusual size of some special organs, and similar characteristics."

4. "Hybrids produce a less amount of pollen and fewer seeds than their parents, and they often produce none. In cross-breeds this weakening of the reproductive powers does not occur. The flowers of sterile or nearly sterile hybrids usually remain fresh a long time."

5. "Malformations and odd forms are apt to appear in hybrids, especially in the flowers."

Some of the relations between hybridization and crossing with narrow limits are stated as follows by Darwin: "It is an extraordinary fact that with many species flowers fertilized with their own pollen are either absolutely or in some degree sterile; if fertilized with pollen from another flower on the same plant, they are sometimes, though rarely, a little more fertile; if fertilized with pollen from another individual or variety of the same species, they are fully fertile; but if with pollen from a distinct species, they are sterile in all possible degrees, until utter sterility is reached. We thus have a long series with absolute sterility at the two ends; at one end due to the sexual elements not having been sufficiently differentiated, and at the other end to their having been differentiated in too great a degree, or in some peculiar manner."

The difficulties in the way of successful results through hybridization are, therefore, these: the difficulty of effecting the cross; infertility, instability, variability, and often weakness and monstrosity of the hybrids, and the absolute impossibility of predicting results. The advantage to be derived from a successful hybridization is the securing of a new variety which shall combine in some measure the most desirable features of both parents; and this advantage is often of so great moment that it is worth while to make repeated efforts and to overlook numerous failures. From these theoretical considerations it is apparent that hybridization is essentially an empirical subject, as the results are such as fall under the common denomination of chance. And, as it does not rest upon any legitimate function in nature, we can understand that it will always be difficult to codify laws upon it.

Among the various characters of hybrid offspring, I presume that the most prejudicial one is their instability, their tendency still to vary into new forms or to return to one or the other parent in succeeding generations; it is difficult to fix any particular form which we may secure in the first generation of hybrids. At the outset, we notice that this discouraging feature is manifested entirely through the fact of reproduction, and we thereby come upon what is perhaps the most important practical consideration in hybridization, — the fact that the great majority of the best hybrids in cultivation are increased by bud-propagation, as cuttings, layers, suckers, buds or grafts. In fact, I recall very few instances in this country of good undoubted hybrids which are propagated with practical certainty by means of seeds. You will recall that the genera in which hybrids are most common are those in which bud-propagation is the rule; as begonia, pelargonium, fuchsia, gladiolus, rhododendron, roses, and the fruits. This simply means that it is difficult to fix hybrids so that they will come "true to seed," and makes apparent the fact that if we desire hybrids we must expect to propagate them by means of buds. And this, too, is a point which appears to have been overlooked by those who contend that hybridization must necessarily swamp all results of natural selection; for, as comparatively few plants propagate naturally by means of buds, whatever hybrids might have appeared would have been speedily lost, and all the more, also, because, by the terms of their reasoning, the hybrids would cross with other and dissimilar forms, and therefore lose their identity as intermediates. Or, starting with the assumption that hybrids are intermediates, and would therefore obliterate specific types, we must conclude that they should have some marked degree of stability; but, as all hybrids tend to break up when propagated by seeds, it must follow that bud-propagation would become more and more common, and this is associated in nature with decreased seed-production. Now, seed-production is the legitimate function of flowers; and we must concede that, as seed-production decreased, floriferousness must have decreased; and that, therefore, pronounced intercrossing would have obliterated the very organs upon which it depends, or have destroyed itself.

But I may be met by the objection that there is no inherent reason why hybrids should not become stable through seed-production by in-breeding, and I might be cited to the opinion of Darwin and others that in-breeding tends to fix any variety, whether it originates by crossing or other means. And it is a fact that in-breeding tends to fix varieties within certain limits, but those limits are often overpassed in the case of very pronounced crosses, whether cross-breeds or true hybrids. And if it is true, as all observation and experiments show, that sexual or reproductive powers of crosses are weakened as the cross becomes more violent, we should expect less and less possibility of successful in-breeding; for in-breeding without disastrous results is possible only with comparatively strong reproductive powers. As a matter of fact, it is found in practice that it is exceedingly difficult to fix pronounced hybrids by means of in-breeding. It sometimes happens, too, that the hybrid individual which we wish to perpetuate may be infertile with itself, as I have often found in the case of squashes. It is often advised that we cross the hybrid individual which we wish to fix with another like individual, or with one of its parents. These results are often successful, but oftener they are not. In the first place, it often happens that the hybrid individuals may be so diverse that no two of them are alike; this has been my experience in many crosses. And, again, crossing with a parent may draw the hybrid back again to the parental form. So long ago as last century Kœlreuter proved this fact upon nicotiana and dianthus. A hybrid between *Nicotiana rustica* and *N. paniculata* was crossed with *N. paniculata* until it was indistinguishable from it; and it was then crossed with *N. rustica* until it became indistinguishable from that parent. Yet there is no other way of fixing a hybrid to be propagated by seeds than by in-breeding, so far as I know. Fortunately, it occasionally happens that a hybrid is stable, and therefore needs no fixing.

In this connection I may cite some of my own experience in crossing egg-plants and squashes; for, although the products were not true hybrids in the strict interpretation of the word, many of them were hybrids to all intents and purposes, because made between very unlike varieties, and they will serve to illustrate the difficulties of which I speak. Offspring of egg-plant crosses were grown in 1890, and upon some of the most promising plants some flowers were self-pollinated. But these self-pollinated seeds gave just as variable offspring in 1891 as those selected almost at random from the patch; and, what was worse, none of them reproduced the parent, or "came true to seed," and all further motive for in-breeding was gone. My labor, therefore, amounted to nothing more than my own edification. My experience in crossing pumpkins and squashes has now extended through five years; and, although I have obtained about one thousand types not named or described, I have not yet succeeded in fixing one. The difficulty here is an aggravated one, however. The species are so exceedingly variable that all the hybrid individuals may be unlike, so that there can be no crossing between identical stocks;

and, if in-breeding is attempted, it may be found that the flowers will not in-breed. And the refusal to in-breed is all the more strange because sexes are separated in different flowers upon the same plant. In other words, in my experience, it is very difficult to get good seeds from squashes which are fertilized by a flower upon the same vine. The squashes may grow normally to full maturity, but be entirely hollow, or contain only empty seeds. In some instances the seeds may appear to be good, but may refuse to grow under the best conditions. Finally, a small number of flowers may give good seeds. I have many times observed this refusal of squashes (*Cucurbita Pepo*) to in-breed. It was first brought to my attention through efforts to fix certain types into varieties. The figures of one season's tests will sufficiently indicate the character of the problem. In 1890, one hundred and eighty-five squash flowers were carefully pollinated from flowers upon the same vine. Only twenty-two of these produced fruit, and of these only seven, or less than one-third, bore good seeds, and in some of these the seeds were few. Now, these twenty-two fruits represented as many different varieties, so that the ability to set fruit with pollen from the same vine is not a peculiarity of a particular variety. The records of the seeds of the seven fruits in 1891 are as follows: —

Fruit No. 1. — Four vines were obtained, with four different types, two of them being white, one yellow and one black.

Fruit No. 2. — Twenty-three vines. Fifteen types very unlike, twelve being white and three yellow.

Fruit No. 3. — Two vines. One type of fruit which was almost like one of the original parents.

Fruit No. 4. — Thirty-two vines. Six types, differing chiefly in size and shape.

Fruit No. 5. — Twenty vines. Nineteen types, of which ten were white, eight orange, one striped, and all very unlike.

Fruit No. 6. — Thirteen vines. Eleven types, — eight yellow, two black, one white.

Fruit No. 7. — One vine.

These offspring were just as variable as those from flowers not in-bred, and no more likely, apparently, to reproduce the parent. These tests leave me without any method of fixing a pronounced cross of squashes, and lead me to think that the legitimate process of origination of new kinds here, as, indeed, if not in general, is a more gradual process of selection, coupled, perhaps, with minor crossing.

I will relate a definite attempt towards the fixation of a squash which I had obtained from crossing. The history of it runs back to 1887, when a cross was effected between a summer yellow crookneck and a white bush scallop squash. In 1889 there appeared a squash of great excellence, combining the merits of summer and winter squashes with very attractive form, size and color, and a good habit of plant. I showed the fruit to one of the most expert seedsmen of the country, and he pronounced it one of the most promising types which he had ever seen; and, as he informed me that he had fixed squashes by breeding in and in, I was all the more anxious to carry out my own convictions in the same direction. It is needless to say that I was very happy over what I regarded as a great triumph, and I remember that I experienced a keen feeling of satisfaction that I had been able to overcome nature's prejudices. Of course I must have a large number of plants of my new variety, that I might select the best, both for in-breeding and for crossing similar types. So I selected the very finest squash, having placed it where I could admire it for some days, and saved every seed of it. These seeds were planted upon the most conspicuous knoll in my garden in 1890. It was soon evident that something was wrong. I seemed to have everything except my squash. One plant, however, bore fruits almost like the parent, and upon this I began my attempts towards in-breeding. But flower after flower failed, and I soon saw that the plant was infertile with itself. Careful search revealed two or three other plants very like this one, and I then proceeded to make crosses upon it. I was equally confident that this method would succeed. When I harvested my squashes in the fall and took account of stock, I found that the seeds of my one squash had given just as many different types as there were plants, and I actually counted one hundred and ten kinds distinct enough to be named and recognized. Still confident, in 1891 I planted the seeds of my crosses, and as the summer days grew long and the crickets chirped in the meadows, I watched the expanding squash blossoms and wondered what they would bring forth. But they brought only disappointment. My squash had taken an unscientific leave of absence, and I do not know its whereabouts. And when the frost came and killed every ambitious blossom, my hope went out and has not yet returned.

Let us now recall how many undoubted hybrids there are, named and known, among our fruits and vegetables. In grapes there are the most. There are Rogers' hybrids, like the Agawam, Lindley, Wilder, Salem and Barry; and there is some reason for supposing that the Delaware, Catawba and other varieties are of hybrid origin. And many hybrids have come to notice lately through the work of Munson and others. But it must be remembered that grapes are naturally exceedingly variable and the specific limits are not well known, and that hybridization among them lacks much of that definiteness which ordinarily attaches to the subject. In pears there is the Kieffer class. In apples, peaches, plums, cherries, gooseberries, blackberries and dewberries, there are no commercial hybrids. The strawberry is doubtful. Some of the raspberries, like the Caroline and Shaffer, appear to be hybrids between the red and black species. Hybrids have been produced between the raspberry and blackberry by two or three persons, but they possess no promise of economic results. Among all the list of garden vegetables (plants which are propagated by seeds) I do not know of a single authentic hybrid; and the same is true of wheat, — unless it be the Carman wheat (rye varieties become prominent), — oats, the grasses, and other farm crops. But among ornamental plants there are many; and it is a significant fact that the most numerous, most marked and most successful hybrids occur in the plants most carefully cultivated and protected, — those, in other words, which are farthest removed from all untoward circumstances and an independent position. This is nowhere so well illustrated as in the case of cultivated orchids, in which hybridization has played no end of freaks, and in which, also, every individual plant is nursed and coddled. For such plants the struggle for existence is reduced to its lowest terms; for it must be borne in mind that, even in the garden, plants must fight severely for a chance to live, and even then only the very best can persist, or are even allowed to try.

I am sure that this list of hybrids is much more meagre than most catalogues and trade-lists would have us believe, but I am sure that it is approximately near the truth. It is, of course, equivalent to saying that most of the so-called hybrid fruits and vegetables are myths. There is everywhere a misconception of what a hybrid is, and how it comes to exist; and yet perhaps because of this indefinite knowledge, there is a wide-spread feeling that a hybrid is necessarily good, while the presumption is directly the opposite. The identity of a hybrid in the popular mind rests entirely upon some superficial character, and proceeds upon the assumption that it is necessarily intermediate between the parents. Hence we find one of our popular authors asserting that, because the kohl rabi bears its thickened portion midway of its stem, it is evidently a hybrid between the cabbage and turnip, which bear respectively the thickened parts at the opposite extremities of the stem. And then there are those who confound the word hybrid with *high-bred*, and who build attractive castles upon the unconscious error. And thus is confusion confounded.

But, before leaving this subject of hybridization, I must speak of the old yet common notion that there is some peculiar influence exerted by each sex in the parentage of hybrids; for I shall thereby not only call your attention to what I believe to be an error, but shall also find the opportunity to still further illustrate the entanglements of hybridization. It was held by certain early observers, of whom the great Linnæus was one, that the female parent determines the constitution of the hybrid, while the male parent gives the external attributes, as form, size and color. The accumulated experience of nearly a century and a half appears to contradict this proposition, and Focke, who has recently gone over the whole ground, positively declares that it is untrue. There are instances, to be sure, in which this old idea is affirmed, but there are others in which it is contradicted. The truth appears to be this, — that the parent of greater strength or virility makes the stronger impression upon the hybrids, whether it is the staminate or pistillate parent. And it appears to be equally true that it is usually impossible to determine beforehand which parent is the stronger. It is certain that strength does not lie in size, neither in the high development of any character. It appears to be more particularly associated with what we call fixity or stability of character, or the tendency towards invariability. This has been well illustrated in my own experiments with squashes, gourds and pumpkins. The common little pear-shaped gourd will impress itself more strongly upon crosses than any of the edible squashes and pumpkins with which it will effect a cross, whether it is used as male or female parent. Even the imposing and ubiquitous great field pumpkin, which every New Englander associates with pies, is overpowered by the little gourd. Seeds from a large and sleek pumpkin which had been fertilized by gourd pollen produced gourds and small hard-shelled globular fruits which were entirely inedible. A more interesting experiment has been made between the handsome green-striped Bergen fall squash and the little pear gourd. Several flowers of the gourd were pollinated by the Bergen in 1889. The fruits raised from these seeds in 1890 were remarkably gourd-like. Some of these crosses were pollinated again in 1890 by the Bergen, and the seeds were sown in 1891. Here, then, were crosses into which the gourd had gone once and the Bergen twice, and both the parents are to all appearances equally fixed, the difference in strength, if any, attaching rather to the Bergen. Now, the crop of 1891 still carried pronounced characters of the gourd. Even in the fruits which most resembled the Bergen the shells were almost flinty hard, and the flesh, even when thick and tender, was bitter. Some of the fruits looked so much like the Bergen that I was led to think that the gourd had largely disappeared. The very hard but thin paper-like shell which the gourd had laid over the thick yellow flesh of the Bergen, I thought might serve a useful purpose, and make the squash a better keeper. And I found that it was a great protection, for the squash could stand any amount of rough handling, and was even not injured by ten degrees of frost. All this was an acquisition, and, as the squash was handsome and exceedingly productive, nothing more seemed to be desired. But it still remained to have a squash for dinner. The cook complained of the hard shell, but, once inside, the flesh was thick and attractive, and it cooked nicely. But the flavor! Dregs of quinine, gall, and boneset! The gourd was still there!

We have now seen that uncertainty follows hybridization, and in closing, I will say that uncertainty also attaches to the mere act of pollinating. Between some species which are closely allied and which have large and strong flowers, four-fifths of the attempts towards cross-pollination may be successful; but such a large proportion of successes is not common, and it may be infrequent even in pollinations between plants of the same species or variety. Some of the failure is due in many cases to unskilful operations, but even the most expert operators fail as often as they succeed in promiscuous pollinating. There is good reason to believe, as Darwin has shown, that the failure may be due to some selective power of individual plants, by which they refuse pollen which is, in many instances, acceptable to other plants even of the same variety or stock. The lesson to be drawn from these facts is that operations should be as many as possible, and that discouragement should not come of failure. In order to illustrate the varying fortunes of the pollinator, I will transcribe some notes from my field book.

Two hundred and thirty-four pollinations of gourds, pumpkins and squashes, mostly between varieties of one species (*Cucurbita Pepo*), and including some individual pollinations, gave one hundred and seventeen failures and one hundred and seventeen successes. These crosses were made in varying weather, from July 28 to August 30. In some periods nearly all the operations would succeed, and at other times most of them would fail. I have always regarded these experiments as among my most successful ones, and yet but half of the pollinations "took." But you must not understand that I actually secured seeds from even all these one hundred and seventeen fruits, for some of them turned out to be seedless, and some were destroyed by insects before they were ripe, or were lost by accidental means. A few more than half of the successful pollinations — if by success we mean the formation and growth of fruit — really secured us seeds, or about one-fourth of the whole number of efforts.

Twenty pollinations were made between potato flowers, and they all failed; also seven pollinations of red peppers, four of husk tomato, two of *Nicotiana affinis* upon petunia and two of the reciprocal cross, twelve of radish, one of *Mirabilis Jalapa* upon *M. longiflora* and two of the reciprocal cross, three *Convolvulus major* upon *C. minor* and one of the reciprocal, one musk-melon by squash, two musk-melon by water-melon, and one musk-melon by cucumber.

This is but one record. Now let me give you another: —

Cucumber, ninety-five efforts: fifty-two successes, forty-three failures. Tomato, forty-three efforts: nineteen successes, twenty-four failures. Egg-plant, seven efforts: one success, six failures. Pepper, fifteen efforts: one success, fourteen failures. Husk tomato, forty-five efforts: forty-five failures. Pepino, twelve efforts: twelve failures. Petunia by *Nicotiana affinis*, eleven efforts: eleven failures. *Nicotiana affinis* by petunia, six efforts: six failures. General Grant tobacco by *Nicotiana affinis*, eleven efforts: eight successes, three failures. *Nicotiana affinis* by General Grant tobacco, fifteen efforts: fifteen failures. General Grant tobacco by General Grant tobacco, one effort: one success. *Nicotiana affinis* by *Nicotiana affinis*, three efforts: two successes, one failure. Tuberous begonia, five efforts: five successes.

Total, three hundred and twelve efforts: eighty-nine successes, two hundred and twenty-three failures.

And now, the sum of it all is this: encourage in every way crosses within the limits of the variety and in connection with change of stock, expecting increase in vigor and productiveness; hybridize if you wish to experiment, but do it carefully, honestly, thoroughly, and do not expect too much. Extend Darwin's famous proposition to read like this: Nature abhors both perpetual self-fertilization and hybridization.

The CHAIRMAN. There is now an opportunity for gentlemen to ask any questions of the lecturer. I know he has not had time to tell us one-half he has learned by his own personal experience. If there are any points which the lecturer has discussed, or any new ones, about which the audience desire to ask, there is now an opportunity to do so.

B. P. WARE (of Marblehead). I have been very glad to hear some reference made to squashes, because that is a special interest with us in Essex County. I would like to ask the lecturer whether he considers the crook-neck squash a distinct species from such varieties as the turban, marrow and Hubbard squashes, and if the latter should be classed with the same species as pumpkins.

Professor BAILEY. Squashes and pumpkins, as we understand the terms, are separate species. The term "squash" has a different meaning in this country from what it has in England, France and Germany. What we call "pumpkins" here are ordinarily called "squashes" in England and on the continent.

Mr. WARE. Then the crook-neck squash is an entirely different species from the marrow, the Hubbard and the turban, — they will not mix?

Professor BAILEY. I do not think they will. I have tried it many times, and have never succeeded in getting a hybrid.

Governor HOARD. I understood the lecturer to say that in-breeding as applied to animals, as well as plants, was nearly always productive of a loss of constitution and power. I would like to ask him if there are not exceptions to that.

Professor BAILEY. Very many. It is well known among seedsmen that it tends to fixity of character; but when carried on for a series of years it will result in the deterioration of the plant.

Governor HOARD. Mr. Dauncey of England, the founder of the Stoke-Pogis family of Jerseys, in-bred constantly. "Stoke-Pogis 3d" traced thirty times back to the cow "Pet;" but Mr. Dauncey managed his system of in-breeding with such skill and discernment that he increased the constitution and vigor of his animals.

Professor BAILEY. Then he certainly practised a series of crosses by which he selected the parents.

Governor HOARD. That is right. In-breeding is like a razor; it will cut your throat or your beard with equal willingness, depending upon how you hold it.

Professor Bailey. Then there is this further consideration which I intended to mention in this connection, — that in-breeding among plants is a much more intense operation than among animals, because in-breeding in all animals is really a cross between two individuals, and you do not get nearly so much of effect in the in-breeding of plants as you do in animals.

The Chairman. While you are thinking up questions, I would like to suggest one myself. Some three or four years ago a report came from the Michigan Horticultural Society which interested a good many of our strawberry growers. It was on the effect that staminate plants have upon the crop of the present year when planted beside pistillate plants. In other words, it is known that we are obliged to plant at short distances staminate plants beside the pistillate in growing the strawberry, and in recent years our greatest improvement in that fruit has been in the pistillate varieties. Now, it was said in this report of the Michigan Horticultural Society that the effect of the staminate berry was very apparent upon the berries of other varieties growing close by. In other words, that in size, in color and in form it had an effect upon the berries. If that is true, you see the importance of the staminate berry that we use. And I see by a recent report that that idea has been endorsed by Mr. Hale of Connecticut, who is one of the largest strawberry growers in New England. I believe Professor Bailey was connected with the Michigan institution when this report was made, and, thinking he may be familiar with the experience of those experimenters and the correctness or incorrectness of the report they sent out, I would like to ask his opinion on the subject.

Professor Bailey. I am very sorry this question has come up, because it is one of those corners into which one is sometimes driven, out of which he cannot emerge very gracefully. It is a mooted point at the present time. My own opinion is an heretical one in regard to the matter. But those experiments were not made at the Michigan college; they were made at the Ohio Experiment Station, and afterwards modified by Professor Lazenby, who made them. But, on the principle that error will travel faster than fact, the first statement he made has got ahead of the later one. So far as I know, there is no effect of the staminate parent upon the fruit formed the same year, in the ordinary acceptation of that term; and yet there is an effect coming about in a sort of secondary way which I will explain to you. As you know, the strawberry is not the fruit; it is a large mass of flesh with the fruits upon the outside. Now, when those little fruits upon the outside are fertilized with pollen from another plant, they develop and grow and the flesh also grows so as to make the berry fill out big and plump in that direction: but when any of these little seeds upon the outside of the berry are not fertilized, then the strawberry at that point ceases to grow so rapidly, little pits appear at those places, the strawberry becomes more one-sided, and we get nubbins. If we have not enough pollen to fertilize all the little seeds, we are very apt to get nubbins. I have satisfied myself that that is the cause, by covering a strawberry carefully and then pollinating half the fruits on the surface; and I found that the strawberry did not fill out upon the other side. If you cut off part of the fruits on the outside, the strawberry will not grow so plump. You may see proof of that fact if you take a nubbin strawberry and examine it, for you will find the fruits not fully grown upon the side which is imperfect. So that there may be a mechanical influence from the fact that there was not enough pollen to fertilize all the seeds on the outside of the berry. But my own opinion is that there is no very marked effect of the pollen the first year in the case of the strawberry. There are several reasons for this opinion. One is an experiment which I conducted some four or five years ago for the purpose of determining this fact; and, although the experiment was not extensive, it seemed to me to indicate that there is no immediate effect of pollen. Other experimenters have arrived at different conclusions, so that the whole matter is in doubt.

The experiments which have been alluded to as coming from Michigan, but which really came from Ohio, seemed to show that the first year or so there was a decided effect; but afterwards Professor Lazenby, who conducted the experiments, whom I know to be a very careful man, said that he thought that effect was not due to the pollen, but to something else. Strawberries are so eminently variable that we can find almost any number of varieties growing side by side. A few years ago a gentleman stated in a public meeting that he had proved to his own satisfaction that a certain pollen had produced a modified berry the same year. I expressed my doubt as to the fact, and said that there was a difference of opinion, and some discussion followed. It seemed that he kept the pollen which he desired to exclude away from his plants by driving down four stakes and throwing a fanning-mill sieve over the stakes to cover the plants. He expected to keep the pollen off the plants in that way, but we know that 10,000 particles of pollen could pass through that sieve and all manner of insects could pass under it.

Governor HOARD. The selection of our seeds is a very important question. I have made some experiments with regard to the selection of seed corn. I have been led out into a new line of thought, and I would like to have the professor analyze it. The ordinary farmer selects his seed corn from the character and appearance of the ear, and goes no further. If the ear is large and promising, he promises to himself large and satisfactory results from the planting of that ear. I took an ear of corn and planted it in one continuous row from the first kernel at the butt of the ear to the last kernel at the tip of the ear, so that the row should represent a long drawn-out ear, each individual kernel standing by itself. The individual equation was very clearly shown, as the professor knows, in the vigor and fertility of the growth of each kernel. That is a mystery; I cannot solve it; I never have found anybody who could, — why one kernel should absorb to itself so much more of strength and rampant growth than another. But I began to think that there were a great many grandfathers and grandmothers in this kernel of corn that I had not taken account of, as there is in me. For instance, I am constantly warring against my grandfathers and grandmothers, and my grandfathers and grandmothers are warring against each other in me. Perhaps that was what Paul meant when he spoke about that which was within ourselves. So I found that I wanted to look a little further in the selection of seed corn, and that was as to the character of the stalk; that if I wanted a strong growing field of corn I must not select the seed from ears that appeared well alone, but I must select it from stalks which had strong virile action. And I was very much gratified with the results of an experiment made in a very imperfect manner, but still sufficient to indicate to me that our farmers need to pay especial attention in the selection of seed corn to the character of the stalk, for that is the secret of the whole matter; and it is as necessary in the selection of seed as in the breeding of animals, that the original stock shall show great individual vitality and strength if we expect to produce a good crop. What would the professor think of that proposition?

Professor Bailey. The proposition is sound in every way, as Governor Hoard has stated it. In fact, we know now that the character of any individual organ is much less important in making a selection for offspring than the character of the whole plant or of the whole animal itself. We have found this to be remarkably true in regard to many of the plants upon which we have worked, especially in the case of the tomato. We find, for instance, that a medium-sized or perhaps even inferior tomato, growing upon a plant which habitually bears good tomatoes, and which is a strong, vigorous and productive plant, will as a rule give better offspring in every sense of the word than seeds from a very large, fine tomato grown upon a plant which habitually bears small, inferior fruit. So, as I say, the character of the whole plant is of more importance than the character of any individual organ upon that plant. In other words, experiments show, so far as they have been tried, that small potatoes from productive hills give better results than large potatoes from unproductive hills.

Governor Hoard. That is right.

E. B. Lynde (of West Brookfield). I would like to ask Governor Hoard a question. He says that he planted one row of kernels from the butt of the ear to the tip. He did not tell us which produced the strongest stalk, — whether it was a kernel planted from the tip or from the centre or from the butt. That is something that I would like to know.

Governor Hoard. Well, sir, the result was just as mixed as could be. I had strong stalks and weak stalks from kernels at the butt, and I had strong stalks from small kernels and weak ones from large kernels. Indeed, the diversity was most troublesome. That individual equation is a great mystery to me.

Mr. LYNDE. I would like to ask the professor if the nourishment which nourishes the stem until it forms the leaf is not stored within the kernel of corn until the leaf is formed? If that is so, then the small kernel at the tip of the corn could not have as much nourishment as the large kernel in the centre. Now, I want to know why that small kernel should produce just as vigorous a stalk as a kernel in the centre.

Governor HOARD. I would just add one word. You may figure upon nourishment as much as you please, but, after all, you must be amenable to the law of heredity. The professor gave you one little point there, and that was, that virility was never indicated by size. I served in the army alongside of a little man who could out-march me, out-pack me and out-fight me, and get out of the way sometimes faster than I could. I have observed that the power of virility is the same in men as it is in horses, in dogs and in plants. The question of nourishment as indicated by size is no indication of the innate strength stored up resulting from inherited vigor.

T. S. GOLD (secretary of the Connecticut Board of Agriculture). I have tried experiments similar to the one described by Governor Hoard. I was taught to shell off the kernels from the butt and the tip of the ear, to reject those from the butt and the tip, and plant only the kernels from the central, sound part of the ear. But afterwards I heard that if we wanted long ears we must plant the kernels that grow at the tip. I have repeatedly taken an ear of corn, as Governor Hoard did, and planted it hill by hill, beginning at the tip and going through to the butt of the ear. And I have never been able to discover any difference in the result. There has been more or less variation, but the kernels from the butt, the tip and the central part (three or four kernels being put in a hill) have come along with the same degree of vigor. They were put in large and small, beginning at the tip and planting by course, until I got to the butt. This experiment has been tried repeatedly, and with the same general result.

Mr. LYNDE. This is a practical question for farmers. I understand from Governor Hoard's theory that if he were going to select seed wheat he would not care to select a plump, full kernel, he would just as soon take a small, shrivelled one.

Governor HOARD. I want to say that I did not say any such thing.

Mr. LYNDE. Would not any one infer that to be the proper thing to do from what you have said?

Governor HOARD. If they did they would misunderstand me. I am not always fortunate in putting my meaning into speech, so I will stand corrected always if a man misunderstands me, for I ought to make him understand me. My idea was that we should select seeds from good plants; that we should take a good ear of corn from a strong-growing stalk; that it was essential to pay attention to the stalk, because the character of the stalk indicated the virility of its parentage, and the ear did not indicate that so clearly.

THEODORE LOUIS (of Wisconsin). The cultivation of corn is one of my specialties. I live at the extreme limit of the corn belt, so to speak, in the north-western part of Wisconsin. It was once a question if we could successfully grow corn in that northern climate. I found that in order to secure a good crop I must select the largest and the best ears, and especially the earliest. I made in my early years the mistake of planting simply the centre of the ear. I found that I had less bearing stalks in my field than when I afterwards planted the entire ear. Of course I selected a perfect ear, and I can only select an early perfect ear while it is yet upon the stalk and while it shows its earliness by the yellow leaf. In this way I get corn that ripens from September 1 to the 5th. I found, as I have said, that when I rejected the tip I had less bearing stalks in my field than I had when I planted the whole. The question of the effect of the stalk has been a controverted point between Governor Hoard and myself. I did not care to look at the stalk; I considered that the best-developed ear would give me the best result. It had never occurred to me that the good ears always grow upon a large stalk; but there may be more in Governor Hoard's theory than I suppose. But it is a fact which my experience bears out that the kernels from the tip are essential for a successful crop.

Professor Bailey. If we are going to make a success of the business of growing corn or any other plant, we have got to get variations for selection. We should not take seeds from any particular part simply because we get a less amount of variability. It is variability that we must have first, in order to get some basis of selection for future progress. The first thing we should do to improve any species of plant is to make it vary in some direction so as to break its type; and after the type is broken various varieties begin to appear, and then we can select those individual variations which are best for our purposes. Now, if we take simply the kernels in the middle of an ear, we get them very much alike in their general character. If we take them from the whole ear we have kernels fertilized at different times. There are more variations than in those kernels that come from the middle of the ear, and from that great variability we can select those particular kinds which we wish to propagate.

I am glad that Governor Hoard has brought out a point which I was going to emphasize a moment ago; namely, that the amount of nutrition is not the measure of the virility of the embryo contained in the seed. Although as a rule the more nutriment a seed has the stronger will be its character, simply because it has been developed as a rule upon stronger parents, still it does not follow that the amount of nutriment in a seed is any measure of the strength of the resulting plant. And yet there is always a greater chance of getting more virile seed if we take that which is the largest. It is so with garden seed. The best results come from those seeds which are largest, and especially if the plants which result from them are allowed to struggle for themselves in the garden, where the fittest will survive. I always make experience the rule that guides me in my practice; and therefore, while I must say that the amount of nutritive matter is no measure of virility, I must also say that we are more apt to get a satisfactory result if we take the larger seeds. The two usually go together, and yet they are not necessarily correlated with each other. Just why they are not is a question very difficult to answer.

Governor HOARD. What I mean by "virility" is the power of impressibility upon the offspring. It is my idea that large nutrition does not necessarily carry with it that quality, but the one is often associated with the other. When these questions are asked which are so difficult to answer, I often have brought to my mind the reply of one of my little girls, who, when I asked her certain questions, used to say, "You tell me."

Mr. LOUIS. While the professor was making his statement that virility was not dependent upon the size of the seed. it occurred to me that something depends upon the preservation of the seed. I find that if I take a kernel of corn which has been exposed to frost and plant it in the spring, if the spring is cold and backward that kernel is very apt to decay; while if I take a kernel of corn and fire-dry it, as my practice is, get it thoroughly dry before freezing weather comes, that kernel will stand cool, wet weather for almost a fortnight after planting, and still give a vigorous growth. Not the size, but the strength, ought to be the measure of virility in the seed.

Professor BAILEY. That is true, also.

NATHAN EDSON (of Barnstable). I would like to ask the professor whether, if we select our seed corn from stalks that have two or more ears, we are likely to get corn that will bear more ears to the stalk.

Professor BAILEY. I should expect a tendency in that direction.

Mr. LORD (of Templeton). I once took an ear of corn and commenced at the butt and shelled it off and planted the kernels along from the butt to the tip, marking the spots in the row where the different parts of the ear were planted. I could never see any difference between the corn coming from the kernels at the butt and that coming from the kernels at the tip. I plant small potatoes, — not the very smallest, but those rather small in size. I have planted potatoes for nearly twenty years with a machine that cuts them, drops the pieces, puts in the fertilizer and covers them. I have never had better potatoes than when I have planted small ones. I think they run the most even; I have them almost all of a size. I would like to ask the essayist a question in regard to squashes. Will the seed which comes from the stem end produce a different kind of squash from that which comes from the seed end? Will the seed that comes from the stem end produce squashes more like the parent squash than that which comes from the other end?

Professor BAILEY. I have tried it. I have planted seeds from both ends and from the middle, and have never found any difference in the result. I do not think there is any.

M. P. PALMER (of Groton). I would like to ask the essayist if there is any such thing as planting squash seeds and getting a crop of pumpkins?

Professor BAILEY. That depends upon your definition of "squashes" and "pumpkins" entirely. Just what do you mean by a field pumpkin?

Mr. PALMER. I mean the old-fashioned pumpkin, such as we make pies of.

Professor BAILEY. No, sir; there is no such thing. If you mean by "squashes" those like the Hubbard and marrow type, and if you mean by "pumpkins" those like the old-fashioned type, there is no such thing.

Mr. PALMER. You would say it is impossible?

Professor BAILEY. It is impossible; yes, sir.

Mr. PALMER. I have had experience this year in planting that kind of seed and getting a crop of pumpkins.

Professor BAILEY. Some few years ago I purchased something like a bushel of what purported to be English lawn grass seed. But instead of getting lawn grass I got several kinds of European weeds. Very likely the seed which has been spoken of was pumpkin seed, not squash seed.

Professor SHALER. I have planted corn in Massachusetts and in Kentucky, and have had occasion to avail myself of those curious geographic varieties which we have succeeded in creating of that plant. You are all aware that when Indian corn came from the Indians it was a tolerably variant plant; but it is pretty clear that when the Indians had it it varied very much less than at the present time. We have succeeded in producing varieties which will grow much nearer the pole than the corn which the Indians gave us. Those peculiar varieties have been developed here and there by carrying the seed to other fields than those in which it was grown. In Kentucky we often have droughts in the spring and early summer which injure the corn so that when the season gets along towards the first of July we have a blasted crop. I found that if I could get the Canada flint, as we used to call it, — and I suppose it is called by that name now, — and plant it in Kentucky, I could make a crop in a hundred days; but when I undertook to grow the same plant the second year, I found that its ripening period was prolonged, and it was less satisfactory. On the other hand, while this corn would ripen in Kentucky in about a hundred days, if you take the large, tall-growing, coarse corn cultivated in Alabama twenty years ago, and plant that in Kentucky, you find it takes at least 40 per cent longer before it comes to ripening. Now, it seems to me it would be well if we could in some way get a system of seed exchanges by which peculiar varieties of corn, those adapted to special locations, could be distributed. I believe we can obtain corn from Canada that can be planted as late as the first ten days of July with a reasonable chance of securing a crop. It seems to me that one practical point is that these varieties should be rendered accessible through some form of exchange, so that they can be had in case of need. The theory of planting, that is, whether the seed should be selected from the middle of the ear or from either end, seems to me of interest; but I must confess, from what experiments I have made, which have not been many, and also from the theories on the subject which I derived from the work of the botanists, that it seems to me there is no reason to expect that the difference in the position of the kernels on the ear will have any considerable effect on the plant. If you consider what it is that determines the type of a plant, — if you take those flowers (referring to a basket of chrysanthemums and other flowers on the platform), which are the forerunners of fruit, and consider what determines their form and their other properties, you find that it is only in part the influence that the grower has had upon them recently. By far the greater part of those inherited impulses which generally determine the type and character of a plant have had their foundations in the immemorial past. Those foundations were laid generations, perhaps thousands of years, ago. Any change which we can produce by any methods of culture which we can apply to it is only a small part of what has been done by nature in this long history. If we would breed any animal or plant, we must remember that the share which we can have in its ancestry as compared with the total of its ancestry is extremely small. Therefore it is that we have such difficulty in breeding things away from their ancient standard; and therefore we may believe that what little differences we can make here and there in taking seed from one part of the ear or the other must have but a very small bearing in determining the condition of the crop. You see it in our own race. A man is determined somewhat by his own character, but the more essential features which make him a man are the properties of his race, are the properties of his species, are common to mankind. They have been in-bred from a practically inconceivable past.

Mr. LYNDE. Is not the necessary corollary from your theory, Governor Hoard, that, if a man should raise his seed corn in hills having only one stalk, and separate it from his other corn in some way, its character would be just what he would ask?

Governor HOARD. It might, if it were not for the fact that where corn is allowed to grow three stalks in a hill we see the same variation in the character of the stalk.

Mr. LYNDE. Would not the conditions of growth under such circumstances develop a better seed, with more virility, more power to impress itself upon the resultant crop, than if raised in any other way?

Governor HOARD. I think it is preferable to plant corn in rows, dropping one kernel in a place. I find it so in Wisconsin. Drop the seed eight or ten inches apart. Be governed by the character of your soil. If your soil is light and weak, drop it farther apart; if your soil is strong, drop it closer, but never less than eight or ten inches apart. In that way I think you will get a larger and better crop than where you plant it in hills and crowd the stalks together.

QUESTION. How much do you get from an acre, governor?

Governor HOARD. That depends upon the land. I am not growing corn now. I have grown as high as one hundred and twenty bushels of ears to the acre on ordinary land. I never did grow one of those very extraordinary crops.

WM. BANCROFT (of Chesterfield). I would like to ask Mr. Newhall how much he gets.

Mr. NEWHALL (of Conway). I have raised the past season, on two and a half acres of sward land, with eleven hundred pounds of fish and potash to the acre, four hundred and fifty bushels of ears and eight tons of fodder. I thought that was a very heavy crop, considering the amount of fertilizer put on the land. The land had been mowed six years without any fertilizer.

Mr. GRINNELL (of Greenfield). Do you think that corn fertilizes as readily where it is sown in the row as when planted in hills?

Governor HOARD. Yes, sir; I think it does. I was much struck with one point that the professor made. Supposing I procure seed from Mr. Louis up in northern Wisconsin, I being in the southern part of the State, and plant his seed and my seed in alternate rows the coming year, and then plant the seed from that crop alone, — what would be the result?

Professor BAILEY. I think the best result would come from the new seed which comes from the admixture.

QUESTION. You would plant those seeds together, rather than in a separate field?

Governor HOARD. I would plant my seed and the foreign seed together, so that they would fertilize each other. Professor Bailey said that experience has shown that the best results were attained in crossing between families of the same type or line. Professor Bailey is sound on that point. I wish to bring forward the following illustrations in support of that statement. I will take among men the Scotch-Irish family, both coming from a similar tribe, the ancient Celts. There are no more virile and powerful men to-day in intellect and impressibility upon men than the Scotch-Irish type. You cross a Scotchman with a German or with a Frenchman, and you get no such result; but the moment you bring those two types of allied families together, the Irish and the Scotch, you get one of the most powerful types that are known among the families of men. They have impressed themselves with wonderful force upon the history of America. We have the same thing in the crossing of the Guernsey and the Jersey in dairy cattle. We get the finest results of cross-breeding between those two families of the butter breeds of cattle, allied in their character. But you cross a Holstein on a Jersey or a Holstein on a Guernsey and you have two dissimilar tendencies and types; there is a struggle for the mastery, and there is a lack of agreement to a common purpose. We may get once in a while a very excellent result, but I have noticed that it is not generally harmonious and successful. We have the same thing in dogs. The pointer and setter among bird dogs is a very harmonious cross, and there is a reinforcement of like talent on each side to a general result in the centre. We have the same thing in the crossing of the Shorthorn and the Polled Angus among beef breeds. Also a like result in the trotter and the running horse amongst speed horses. In all these instances what is termed "the nick" is more kindly progressive to a definite purpose. The old Greek said "The world is ever hungry for a definition," and all there is or should be to our action on these questions is a definiteness of purpose, working towards some definite result. Now, if we breed to diffusion, or, as the old Yankee word was, "scatteration," we will be very apt to get it unless we bring unity of purpose together with unity of types. Another thing. If a man travels in Europe and visits Germany, for instance, among the German tribes of men he will note the wonderful size of the aristocracy among the Germans, — the ruling families, the cultured families, the families which have had an opportunity of a larger mingling of the blood of like type together. Those men are men of large stature, — Count Caprivi, six feet and six inches; Bismarck; Oscar, king of Sweden. In all those men there has been the commingling of allied blood. But go among the peasantry of Europe and you have a tendency to under-stature nowhere consonant with the other classes. One thing you may say conduces to it, and that is nourishment. No doubt the upper classes are better nourished; but there is something due to blood. I heard a man say, in a Wisconsin institute, "Get out with your crosses! I don't want any more of them. I started with Cotswold and I crossed with Merino: then I crossed with Shropshire, and then I crossed with Oxford Downs, and I have crossed them all clear out; my sheep are not worth a continental." He was right. He had not crossed with an agreeing purpose in the breeds, so that the maternal and paternal purpose should be along the same agreeing line. I make these observations simply as an illustration, I think, of the generic truth of what the professor has said.

Professor BAILEY. I am very glad, Mr. Chairman, that the governor has said just what he has, because I think what he has stated brings out one of the most important truths which we can consider in connection with the growing of plants. We all know that what we call cross-breeds in the human race, as, for instance, between the French and the Indians, are people who are weak physically and intellectually, and the more violent the cross the less we think of the cross-breed. A very striking illustration of this fact is seen when we come to that very violent cross, which makes the worst of all cross-breeds, the Indian and negro.

The CHAIRMAN. We are obliged to bring this discussion to a close, in order that the audience may be able to come here again this afternoon. We do not want any one of them to lose what we have in store for them. Therefore this meeting will stand adjourned until two o'clock.

AFTERNOON SESSION.

The meeting was called to order soon after two o'clock.

The CHAIRMAN. The subject of the lecture this afternoon is "The Agricultural Situation," and it gives me great pleasure to introduce to the audience Ex-Governor HOARD of Wisconsin.

THE AGRICULTURAL SITUATION.

BY EX-GOVERNOR W. D. HOARD OF WISCONSIN.

Ladies and Gentlemen, Fellow Laborers in the Agricultural Vineyard: — Repeating the words of your honored chairman, I would say it gives me great pleasure to once more appear before you, and to find that I am alive. A year ago when I met with you I did not know that I should live another year; now I am sure of it. I am correspondingly glad for my own sake; for your sake, you have my sympathy.

I am to say something to you on the agricultural situation. Your worthy secretary wrote me and said that I was to "encompass the situation." You have all heard of the Irishman who captured three British soldiers by *surrounding* them. I have always thought that the situations were needlessly surrendered in that case. I cannot *surround* the agricultural situation in this country to-day. The moment I commenced to write about it, I discovered that it was a very large subject, and I have not finished my voyage of discovery yet.

There are in the United States about eight million farmers. Can any man hope to comprehend their necessities, deficiencies and possibilities? These three conditions make up the life of the farmer; and what the farmer is as a whole, so is agriculture. Who is there that has judgment wide enough or analysis deep enough to encompass the situation of these eight millions of food manufacturers, and deal wisely and justly with all their relations to themselves and the body politic? Right here let me say that I prefer to call the farmer a *food manufacturer*, and not a *producer*. The mischief with the farmer has been the idea that he was a producer. He is not a producer, but a manufacturer; and, if he had held himself amenable to the law of economic manufacture, he would long since have fertilized his judgment by the finer economies that grow out of such a standard of measurement. Of necessity, then, I can only present to you a few of the phases of the agricultural situation.

First, let me say there prevails a wide discontent among the agricultural population of the United States. Demagogue politicians seek to inflame it, with the hope that they may feed upon it. Fools seek to decry it, belittle it, and ridicule it, just as they did the coming of the flood. Wise men, earnest men, good men, should heed it, listen to it, and seek by a patient study of its proportions to comprehend its meaning, extent and probable effect.

First of all, from an ethical stand-point, I want to say to you that the farmer is right in his feeling of discontent. He may not be wise in his manifestation of it, but he has a right to feel as he does, and I hope he will continue to feel worse and worse, until he puts a round stop to some of the villainy of our latter day American life.

In the partnership of industrial forces he is a foundation factor. He is the food producer of the world. Without his labor, skill, fortitude and courage, fifty-seven out of our sixty-five millions would starve. Between him and the consumer stands the immense capital of the dealers in food and the transporters of food, — the middle-men and the railroads. Season after season rolls around, and the farmer finds but a scanty reward for his toil and privation. No other toiler in the land works as many hours and receives as little pay for what he has invested. He sees it, comprehends it. In addition, he sees a steady decline in the producing power of the soil, on which all must depend. The future gives scanty hope in that direction.

Right at this point looms up the important inquiry, "Who is to blame for this state of affairs?" Let us try and look into it. In tracing out this matter, we hold that the farmer himself must be held responsible for very much of the misfortune that affects him. Who but the farmer is to be blamed for the impoverished condition of his farm? God gave him this land, endowed with every element of fertility. The command of the Deity, duty to the State, the meaning of good citizenship, the welfare of succeeding generations, and, lastly, the financial profit of his own business, have all enjoined upon him to keep up the productive power of the soil. The skeleton of waste grins at him in derision, and mocks at him when his fear cometh. Oh, what a sting there is in the reproach of a worn-out farm; still more a worn-out State. The never-slumbering justice of Nature's God metes out punishment for such wickedness of the fathers upon the children, even unto the third and fourth generation, compelling them to expatriate themselves, and seek lands not their home.

We have had schools in abundance; school-houses dot this as they do no other land on earth. Our native American farmers claim to be intelligent. Why have they not been intelligent enough to correct this great evil? Why have they not farmed these lands so that there should be an increase rather than a decrease of productive energy? Why are the farming lands of almost every State in the Union — on an average — weaker by a large per cent than when first taken from the hand of Nature? The ever-present, never-absent, closest necessity of the farmer is fertility. Yet here is the result. Every Eastern State, every Southern State, every Middle State, shows it with painful distinctness. Every Western State that has been devastated with fifty years of American farming is beginning to show it. Why is this? Let me give you my reason, — you need not accept it unless you choose to. It is this: —

The average American farmer has despised knowledge, contemned study and research. He doesn't believe that there is such a thing as a science of agriculture. He doesn't believe that wisdom and understanding concerning farming can be taught to him or his son from books and schools. Look at his own schools, the country district school, the only farmer's school *per se* in the land. What he is, they are. They reflect with the faithfulness of a mirror just the quality and character of the farming intellect that surrounds them. If he believed in the efficacy of teaching the principles of agriculture to his children, would he not provide some simple text-book of that kind for his own children in his own schools? Millions of dollars are being expended in these United States every year for agricultural colleges, and hardly a text-book on agricultural science even in its simplest form — and the simpler the better — in all our country schools; those schools that lie alongside of the farmer, that touch every fibre of his being, from which he has become what he is. Ninety-seven per cent of all the farmers of the United States have received no education except such as they give. The American farmer will admit the necessity of an education for the lawyer, the doctor, the preacher, the editor, the merchant or mechanic. To fit his son for battle in any of these divisions, he will work and save as no other man on earth ever worked or saved. The annals of American farm life abound in examples of sacrifice for the education of children in everything but farming, that are without parallel among any other people. He sees clearly that, if his boy is to understand the *principles* of law, or of medicine, or of mechanics, or of banking, he must look into books and read there the record of the experience and judgment that have gone before him. He must train the intellect to discern a principle in the printed page, and then by practice learn how to apply that principle to produce material results. Are there no principles in agriculture, — that science which includes in its necessities all other sciences? Do you suppose that the farmers who swarmed out of New England and New York into Ohio, Michigan, Wisconsin and the farther West, would have destroyed the fertility of their lands as they have done, if they had been taught in the country schools the meaning of nitrogen, phosphoric acid and potash, as manurial agents? The average farmer must stand up and face the results of his low averageness.

Look at the average cow of the Northern States. What is she good for? Let me tell you. At an expense of several hundred dollars, three years ago I employed Mr. C. W. Jennings to take a thorough census of the cows of the township of Ellisburg, Jefferson Co., N. Y. He spent several months at the task. Ellisburg stood second only, I think, as a dairy town in New York. Every cow was hunted out, and her earnings and expenses thoroughly determined. Mr. Jennings wrote seventeen letters to "Hoard's Dairyman" during the work, detailing with close minuteness all facts, and followed with a general summary.

Dr. Collier of the New York Experiment Station, in a letter to Mr. Jennings, said: —

"You are at liberty to use me as authority for the strongest statements it is possible to make, as to the practical value of the work you did in the town of Ellisburg, in the matter of the cow census. I endeavored to duplicate your work, and sent out twenty-five hundred circulars, asking for replies to questions every intelligent dairyman should have been able to answer. I quote from a reply received from one of them: 'I find on inquiry that there is not one man in one hundred of the average farmers who knows anything about what his cows cost to keep them, nor anything about how much butter or milk his cows yield in the course of a year. In fact, they don't know anything about their cows except that they feed them something, and get some milk and butter.' To my twenty-five hundred circulars," Dr. Collier adds, "I received twenty-seven replies. I have no reason to believe that anyone who had the information refused to give it."

Let me give you in a condensed form what that census disclosed. Understand, at the beginning, that the farmers in that township will average in intelligence on any other subject equal to any township of farmers in the United States. The farmer is trained to see nothing beyond the demonstration in an animal, a tool or a crop; and to that extent has he weakened his intellectuality and to that extent is he open to the charge of a lack of intelligent understanding of the outlines and scope of his own business. The final summing up showed in brief as follows: —

Whole number of dairymen in the town,	356
Whole number of cows in the town,	5,417
Average number per dairy, nearly,	15
Lowest average of earnings per cow in a herd of ten,	$18 38
Highest average earnings per cow in a herd of five,	$81 00

The following is the average earnings per cow, according to herds: —

11 herds, . .	120 cows from	$18 38 to	$20 per cow.
37 herds, . .	528 cows from	20 00 to	25 per cow.
108 herds, . .	1,526 cows from	25 00 to	30 per cow.
105 herds, . .	1,742 cows from	30 00 to	35 per cow.
67 herds, . .	1,049 cows from	35 00 to	40 per cow.
23 herds, . .	366 cows from	40 00 to	45 per cow.
8 herds, . .	62 cows from	45 00 to	50 per cow.
5 herds, . .	139 cows from	50 00 to	55 per cow.
1 herd, . .	4 cows from	52 72 to	– per cow.
1 herd, . .	5 cows from	57 58 to	– per cow.
1 herd, . .	5 cows from	81 00 to	– per cow.

The average cost of keeping a cow in that town was $36.26. The average earnings per cow was $31.74⅕. *The average loss per cow was* $4.51⅘. A very good reason for the loss that is reported is shown in the significant fact that of the three hundred and fifty-six dairy farmers only one hundred and seventy-two read agricultural papers, and only twenty read any dairy paper whatever.

Here is the situation. Three hundred and fifty-six farmers, intelligent on all general topics, born of good, intelligent fathers and mothers, and who maintained a course of winter lectures, — calling in the best talent from New York and Boston, it may be, — and who had been dairymen for years, were so indifferent to dairy intelligence, breeding intelligence, feeding intelligence, in short, cow intelligence, as to make a showing like that. Then take the fact squarely in that these farmers gave a clear illustration of the truth of that saying of Holy Writ, as a man "thinketh in his heart so is he." The effect on the prosperity of that town through the loss per cow was a total annual loss of $24,880.62. No one knows how long this fearful leakage has been going on, sapping the energies and life of agriculture among that people. The reason for this dark showing can be found nowhere else except in *a lack of dairy intelligence.* Had those farmers known better, is it not reasonable to suppose they would have done better? A few of them did understand what was necessary for a profitable success. From this it is evident that the fault did not lie in the season, in the times nor in the location.

Now, what is true in the dairy is just as true in the production of beef, pork or mutton. Thousands upon thousands of poor scrub steers, the product of scrub parentage, and still scrubbier ideas of scrubbiness, flood the markets. From tip of horn to tip of tail you cannot see the faintest record of the use of any brains whatever in their production. They are raised and sold solely for fun. The average farmer is a man of "infinite humor and jest." Two years ago in Canada I saw buyers from Boston, New York and Philadelphia buying mutton sheep and paying five or six cents a pound for them and an additional cent a pound tariff, to get them into the very market which belongs to the United States farmer. At the same time thousands of farmers over here in the United States were shivering over the expiring embers of their thought and pluck, and declaring "Farming doesn't pay."

Why was it the buyer went to Canada? Because he found there a set of English and Scotch farmers who had educated themselves into an understanding of the meaning of the word "mutton." They had made themselves intelligent, first, in the breeding of mutton sheep; second, in feeding and handling mutton sheep, so that the primary object of the breeding should be carried out to suit the demand of the market. Is there anything occult or difficult in this; anything that the mind and brain of the American farmer cannot readily grasp and accomplish? No! Why, then, should not the American farmer supply his own market with just as great success as the Canadian farmer? What is lacking in the American farmer? Simply the same intelligence and energy to carry out that intelligence to a practical end.

What, then, do the necessities of the agricultural situation demand of the American farmer? I answer, in brief: He must cast aside the old, worn-out prejudice against what he terms "Book Farming." He can see, if he has any practical discernment, that his old notions do not fit the situation. Under the guidance of these notions he has been selling out his farm by the bushel, destroying the original capital God gave him in the first place to do business with. He has been trying to wring reluctant success out of a class of farm stock that are incapable of meeting the demand. Steam and electricity have changed all the relations of men. They have compelled new adjustments in the order of our civilization,—new adjustments of law, new adjustments of medicine, new adjustments of the Gospel, even. The life the farmer now lives is four times as expensive as was the one his grandfather lived. His children demand a better education, and the home must take on a larger range of comfort. Community life, in its better roads, bridges and public buildings, brings larger expense to him. He must have a larger revenue. How will he get it? By becoming more intelligent and skilful. As the soil decreases in fertility he must increase in skill. He must sell *skill*. As competition decreases the price of his product, he must decrease the cost of that product. He cannot hope to control the market price. That is wholly out of his power. What shall he do? Exercise a larger intelligence in the matter of reducing the cost of production. How shall he do this? So far as the soil is concerned, by improved methods of tillage, and a determined effort to increase fertility. The gauge of the American farmer has been *acres* of corn, of grain, of hay and of pasturage. (This morning I heard, thank Heaven! a different doctrine enunciated; it was *the number of bushels per acre* that was raised.) Cast aside that standard of management, and let us in the future be governed by the *amount* produced. So far as his farm animals are concerned, breed, feed and handle to some specific purpose. These purposeless, general-purpose cows, sheep and horses, — are they not a delusion and a snare? Thank fortune there can be no general-purpose hog. He is all hog. The farmer must of necessity be a man of rigid honesty and logic. If he is not, of necessity he is a failure. No trickster can succeed with Nature. God's true vicegerent here on earth must be the farmer. All other vocations are based on rules and laws of man's devisement. Not so the farmer. He must interpret the laws that God has made. Great is their mystery. Great must be the comprehension and wisdom that successfully interprets them. Hence he must be a lover of knowledge. He must be teachable. Christ said in effect, "Except ye become as a little child, ye can in nowise enter the kingdom of heaven." Neither can you in any other way enter the kingdom of law, or of medicine, or of mechanics, and especially the kingdom of agriculture. In this kingdom it is only the truth, the whole truth and nothing but the truth, "that shall make you free," and master of the situation.

The Chairman. There is now an opportunity for the audience to ask any questions of the governor, and I hope they will improve it promptly, so that no time may be lost.

Mr. French (of North Hampton, N. H.). What do you consider the greatest drawback to American farming to-day?

Governor Hoard. Ignorance.

Mr. French. I should not place it there. I do not think it is ignorance, I do not think it is lack of knowledge. I do not think that all the chemistry in the world, all the good cultivation and big crops we can raise, — I do not think any of these things amount to very much, unless we can sell our crops for more than they cost. I think that the greatest drawback to American farming to-day is that our markets are not commensurate with our crops.

Governor Hoard. What will enable us to have better markets?

Mr. French. We want not only the markets of South America and Mexico, as Mr. Blaine tells us, but we want the markets of the whole world. We want our own ships and our own sailors to transport our immense surplus products to the four corners of the earth.

Governor Hoard. What will enable us to attain that result? The gentleman gives some very excellent things as objects to be attained, and he and I will not dispute; but, my friends, before we attain them we must be intelligent enough to get them. If there is anything that stands in our way concerning markets to-day, it is ignorance. I said ignorance was the greatest drawback to-day to the American farmer; and I measure the American farmer by myself. My ignorance, my lack of understanding, my lack of judgment, how to dispose of the force that I did have, has constantly cost me fruitless labor; and therefore I would say, as did Solomon, "With all thy gettings get understanding." Now, this is not theoretical, it is practical. For instance, I have received in the past six months, while discussing in my own paper the Babcock milk test, one hundred and eighty letters from farmers, asking me what I meant by a little round dot, a period, before figures! One hundred and eighty letters, asking me what I meant by a decimal point! I have received hundreds of letters from men who would write me confidentially, asking, "What is the meaning of this thing you talk about, *proteine?* What is the meaning of this, what is the meaning of that?" My friends, the intelligent farmer to-day is not doing the farming of the United States. The great mass of all the corn that is raised is raised mechanically, of all the wheat, of all the pork, and of all the dairy products. So that I say that we are keeping two cows to do the work of one. That is a loss. I want to see just half the number of cows in the United States that there are to-day. I want to see them rigidly cut down. I want to see a three-hundred-pound cow in the place of a one-hundred-and-fifty-pound cow. That leaves me the opportunity of keeping one cow instead of two. Intelligence will enable me to make that gain; the lack of it is costing me what I have already.

Mr. LYNDE. I do not believe it is ignorance. I believe that this body of men is composed mostly of practical farmers. I do not believe that it is because of the ignorance of farmers that everything is in the depressed condition that it is now. I will say at once there is nothing that I regret so much as that I did not at an early age receive a thorough education in all that appertains to my calling, — in geology, chemistry and botany. Farmers are not all ignorant. I live in Worcester County, and most of the farmers in Worcester County take an agricultural paper. I myself have had the enlightenment of "Hoard's Dairyman," and take it to-day. The one great reason, — there is more than one, — but the one great reason of the depressed condition of agriculture to-day is overproduction. Mark that! It is no use for us to get up into the air; let us come right down to hard-pan, and stand on the earth. I saw in a paper last week, — I don't know but it was in "Hoard's Dairyman," I think it was, — the statement made by a writer that one reason for the depressed condition of farming is that farmers, instead of keeping a dairy of twenty cows that will make on an average three hundred pounds of butter each, should keep fifteen cows that will make four hundred pounds each; and he says, "How much better that would be!" Well, Mr. Chairman, how much better it would be to keep one cow that will make six thousand pounds rather than fifteen that will make four hundred pounds! The one is just as practical as the other. Is not that true?

Governor **Hoard**. Is one just as practical as the other?

Mr. **Lynde**. One is just as practical as the other. You can accomplish one just as quickly as the other. You will get a selected cow that will make six thousand pounds of butter just as quick as fifteen selected cows that will make four hundred pounds. We do not all keep scrubs in Massachusetts. If you will go up into Worcester County I will show you a farm where there are dairy cows that are not scrubs, and you will find just as good land as there is in Illinois on that farm. As a man who is somewhat anxious to know how he is coming out on the first of January, I have taken an account of stock. I find that to pay the expenses of my family I have got to take two hundred dollars out of the money that I have laid up in better days. I do not happen to be very poor; I have money enough to live on without an income from the farm. And I want to say that that money has been made out of that farm, and the interest of it will support me handsomely without doing anything; but to-day I cannot make the two ends meet, and live as I do live. We farmers have of necessity increased our family expenses because others have increased theirs. The farmer must live as well as others about him. If a farmer does not bring up his children as well as the blacksmith and the shoemaker bring up theirs, dress them as well and send them to school, he will bring up an inferior family.

Mr. **French**. I cannot see the difference between overproduction and a lack of markets. I think we have overproduction. There is no question about that. One year ago to-day I had fifty hogs on my hands. I sent to Newburyport, Portsmouth, Amesbury and Rowley, and I could not find a butcher that would buy them at the going price, — six cents a pound; and the only reason was because those markets were full, they did not want them. I kept those hogs for six weeks. They were as fat as they could be made; they did not gain a pound, probably, after the first of September. I kept them six weeks, simply waiting for an opportunity to sell them at the market price, — six cents a pound. I could only get five cents a pound offered for them in Boston. I kept them, as I say, about six weeks, and then sold them, about half a dozen at a time, at six cents a pound, but they did not pay the cost of keeping. I have on my hands to-day fifty more; half of them are as fat as they need be, but there is no ready market for them.

THEODORE LOUIS (of Wisconsin). That comes somewhat in my line. The governor has stated that the difficulties of the agricultural situation to-day come from a lack of business qualifications as well as knowledge in the farmer. The gentleman last up said he had fifty hogs for which he was offered five cents a pound dead weight, and he kept those hogs six weeks. If he had taken a pencil and figured out the food consumed by those hogs, he would have found that he was losing money by keeping them. Why not, then, do as other business men do, — sell his product for a less price, if he cannot get what he thinks he ought to have? Why should he not have shipped those hogs to Boston, instead of subjecting himself to the expense of feeding them for six weeks? I would look at this question simply from a business point of view. The reason why he could not sell his hogs was because there was an overplus of hogs in the market. It was the deficiency of corn in the West that made the farmers there throw their hogs upon the market, because they had nothing to feed them with. The present situation of the hog market is this, — that the farmer of the corn belt, instead of receiving forty-five or fifty cents for his corn, anticipates that Germany will consume a great deal of our Indian corn; he knows that there is no old corn in the cribs of the country, and he calculates upon getting a higher price. But the packer at the same time makes the other calculation. The Chicago, the St. Louis and the Boston packers make their calculation that when the packing season commences there will be a fall in the price of hogs. They know precisely the number of hogs in the country. Each packer knows how many hogs we have in the country, because every drover and buyer in the West will take the statistics of the number of hogs as he goes about buying. Hogs are now being sent to market in great numbers. Chicago received on an average last week sixty thousand a day. The receipts exceeded anything ever known in that city. The average weight of those hogs was from one hundred and twenty to one hundred and fifty pounds. They were not ready for market. Had those men in a business-like way held up on the hogs, the market would not have been glutted, and the packers would have been obliged to give more than five cents a pound live weight. Now, I consider this question in its business features. I have studied those features carefully. I have travelled in my business over the Western States, and have seen the different conditions.

Mr. Mills. I would like to ask, as a matter of information, the weight of the hogs that the gentleman on the other side of the hall (Mr. French) did not find a market for.

Mr. French. My hogs weighed somewhere from three to four hundred, I think. They were as fat as they could possibly be made.

The Chairman. What age were they?

Mr. French. Perhaps a year and a half, or thereabouts. They were raised in Woburn, Mass. I bought them as shoats and fatted them, but there was no money in them whatever at that price, and there was not this year. I don't think they paid for the cost.

Mr. Mills. I heartily sympathize with the gentleman; but, with all due respect to him, it seems to me that he has made a great mistake all the way through. As I understand the feeding of hogs to-day, the man who brings a hog to weigh two hundred pounds ought to sell that hog at once, and commence to feed another. A man who is raising hogs ought to be intelligent enough to understand that the moment his hog has reached two hundred pounds he should dispose of him, and get another hog or a pig. I think that is a point that may be of value to my friend on the left, and may possibly enable him to make money out of feeding hogs.

Governor Hoard. Mr. Chairman, I want to say a word on this hog question. I think my friend here on the right has convicted himself, the same as I have in past years, in getting hold of the wrong end of the question, when he undertook to handle eighteen-months hogs and make money out of them. My son and myself handle four creameries and three cheese factories, and we have handled, until our patrons got too intelligent for us, quite a large number of hogs. Now, we made some very interesting experiments that cost us between three and four hundred dollars to demonstrate, — for instance, the point of profit in a pig, or rather the law that governed profit; we wanted to instruct our patrons, and this was the result. We commenced with pigs weighing thirty, forty or fifty pounds, and brought them up to three hundred pounds weight. We weighed the feed, and, as nearly as practical men could get at this thing we determined this: that, up to the weight of fifty pounds, a pig increases in his weight in proportion to the food he consumes; that is, he puts on flesh with an increasing ratio; but that after he passes fifty pounds he commences steadily to decrease, and gives you less and less growth for the amount or value of the food he consumes. So that at one hundred pounds weight it costs ten per cent more food (and that means money) to produce a pound of meat than it did at fifty pounds weight; at one hundred and fifty pounds it costs seventeen per cent more food to produce a pound of meat than it did at fifty; at two hundred pounds it costs twenty-four per cent more food to produce a pound of meat than it did at fifty; at three hundred pounds it costs from thirty-four to forty-eight per cent more food, this variation being due to the character of the hog. It costs more and more as the hog grows larger and heavier. What is the philosophy of this? It is the food of support. Take a hog weighing two hundred and ninety-nine pounds. The farmer says, " When he gets to weigh three hundred pounds I will sell him." How often do you hear that said. Now, you have to feed and support that two hundred and ninety-nine pounds; you have to hold it there every day and every minute, or it drops back to two hundred and ninety-eight pounds, and you have two pounds to make instead of one. Now, that constant expense of holding whatever you have secured in the weight of an animal is a fact that seems to be entirely lost sight of; but it amounts to a tremendous sum, and consequently we need constant study along this little point called assimilation, — the assimilative ratio of our animals. We need to watch them with care, and when we find they have gone beyond the point of *profitable* assimilation we must get rid of them at once. Now, how much is that food of support? I do not know whether it is exactly true or not, but the German experiments show that it is about two per cent each day of the live weight of an animal. Now, two per cent of three hundred pounds is six pounds of food that must be consumed by a hog every day to hold its weight. Now, consider how much you have had to expend upon a hog that weighs three hundred pounds in order to hold each pound of weight before you can get a pound more. That is why we find that we cannot raise and feed an eighteen-months pig and make a cent of money out of it. We must get that hog to market within from six to eight months from the time he is born; and we rarely find that we can make any money on a pig over two hundred pounds weight. If we can get him to two hundred pounds when he is in the assimilative or growing period, and have him take his food eagerly when he is in that condition, we can sometimes make a profit. Now, it is the lack of knowledge that beats us here. It was with me. I believe it was because I did not understand the right principle and the law of its action as I ought to have understood it, that has brought me most of my ill luck through life. Let us be honest and courageous in facing hard facts.

Mr. French. I want to correct myself in regard to the age of my hogs. They were raised by Mr. Cummings of Woburn, and I think they were about two months old when I bought them, in the spring of the year. I turned them as soon as I could in the fall, and tried to turn them, as I said, about the first of September, so that they could not have been probably more than a year old when they were sold. I am seventy-three years of age, and have been a farmer all my life. My father was a minister of the Gospel for fifty years in the town where I live, and they tried to make a minister of me, but they did not succeed. I loved farming, and love it still. . I believe in farming. I love it for its surroundings, I love it for its home comforts; and I have always stood up in favor of the farmers, although I think they work harder for less money than any other class in the whole community. When I was a boy my father had no money, and I worked many a day for a quarter of a dollar. I have got up at four o'clock in the morning and gone into Hampton marsh and polled hay until the bell rang for nine o'clock at night, for two shillings a day; and when I got the two shillings my father would put them into the savings bank for me, so that when I was eighteen years of age I had about as many dollars in the savings bank as I was years old. Between the ages of twenty and twenty-five I cleared about a thousand dollars by taking a farm on shares and keeping school in the winter. When I was twenty years old I raised thirteen hundred bushels of potatoes, carrying them into the cellar, taking them out and marketing them myself for about twenty-eight or thirty cents per bushel, having only one-half of the crop. At twenty-five I was married, and married a farm with my wife; and, although I say it, she was beautiful as a rose, as smart as a whip and as neat as a pin. She has been the making of me. When I used to go courting Sunday nights I found her milking, and after we were married she used to help me about the milking, and sometimes even turn the grindstone and help me rake up the salt hay. The next morning after I was married the man who was on the farm said to me, "John, you have here one horse, a few sheep four cows and a heifer; you had better sell the heifer, for four cows are all you can summer on this place and all you can winter." I made no reply to it, but thought I might improve upon that. I am now upon the same place, having added a few acres to it, and we can keep from forty to fifty cows, ten horses, a dozen or fifteen young creatures and fifty hogs; and those animals are all kept a great deal better than those four cows were when I went there. They are all kept clean and nice as a stable of horses; and instead of having a barn sixty feet long two-thirds full of a poor quality of hay, I now fill a barn one hundred and fifty feet long to the ridge-pole every year with the first quality of hay. I have laid something like three miles of drain tile; so that, instead of raising water-soaked grass, I now raise the best of grass. We have cellars under all our buildings, and we manufacture some four hundred two-horse loads of manure a year. Now, I have frequently said, although there are so many drawbacks to farming, that a man who owns a good, compact farm, substantially enclosed and under good cultivation, with convenient buildings, in good repair, and implements of husbandry kept well housed and bright, good farm stock that is well tended and taken care of, is in the enjoyment of good health, is happy in his family relations, and has a few hundreds or a few thousands (which of course is better still) of dollars to fall back upon in case of misfortune or sickness or a rainy day,— I have said, and I say now, that such a man, if he is satisfied with reasonable enjoyments, is as well and better off than the millionaire or the king on his throne. And I say that we have scores and scores of farmers in rocky, sterile New Hampshire who either have or could have all these blessings if they chose. They are surrounded with all the comforts and many of the luxuries of life. They have no house rent to pay, have no fire-wood to buy, and if they want to take a drive they have only to harness their own team and go when and where they please; and I say that farmers, if they had markets enough for their products, and could realize prices commensurate with the cost of their products, would be the best off of any class of people in the world.

Mr. Lynde. I think this audience must see now that it is not ignorance that brings farming into its depressed condition to-day. Here is a man whom every person in the audience knows from the account he has given of his past life is not an ignorant man, — that is settled; but still this man says that our markets are not sufficient to afford prices which are commensurate with the labor and expense of farming, and the reason of it is, as he says, that we want more markets. I say it is because of the surplus of our products. Take the statistics of cattle in this country. From 1880 to 1889, the increase was fifty-one per cent, while the population increased just thirty per cent. Now, what is the result of it? With this large surplus the purchaser makes the price. Now, reverse that: suppose the cattle of the country have increased thirty per cent and the population has increased fifty-one per cent; then who names the price? The producer.

Governor Hoard. One word, and I will not say any more. This is a shield set between us. My friend here is talking about one side of it, and I am talking about the other. Now, I am not disputing these other things, but I do maintain that we need more intelligence. Take the conditions that my two friends here have named, one the lack of markets and the other overproduction. The poor people in Boston will not tell you there is any overproduction. I would like to see the day when the finest creamery butter in the United States will not bring over twenty cents a pound; but I would also like to see my intelligence grow to that extent that I can produce it for twenty cents a pound and make just as much money as I can now when I sell it for thirty cents a pound.

Mr. LYNDE. Do you have any trouble with the labor question out West? Is it difficult to get labor at a fair price?

Governor HOARD. Yes, sir. Mr. Hiram Smith of Sheboygan County, who is now dead (Heaven rest his soul!), one of the grandest men we ever had in Wisconsin, kept twenty-five cows on two hundred acres of land. He did not think that he was making profit enough out of the business, and he kept increasing the production, not increasing the primary capital, until he had one hundred cows on the same amount of land. He made a very close calculation, and he found that he was producing his butter, for which he was getting twenty-five cents a pound, at absolutely less cost than his neighbor, who was receiving sixteen cents a pound; that while he got an additional price on account of the excellence of his product he had learned to decrease the cost of production by increasing the capacity of the cow and increasing his own understanding how to handle her, until his butter was costing him very much less per pound than it was when he had only twenty-five cows. Is there not an opportunity there? With all this overproduction, is there not an opportunity for us to do just as the manufacturer does everywhere, — apply a larger degree of intelligence to this problem of how to produce these farm products at less cost? And is not the difficulty with us a lack of understanding? I said, when I was asked what was the greatest drawback of the farmer, "ignorance," using the word in a broad sense. Well, it may have sounded harsh. I do not say that the gentlemen before me are ignorant. I would not like to have it said that I am ignorant. God knows that I am, however, tremendously so. But I am confronted every day with this constant prayer in my own mind, — "Oh, Lord, give me more understanding." I met Mr. Hughitt, president of the Northwestern Railway, on the train coming down to New York, and in talking with him about these questions he said: "You are confronted with the same struggle for better understanding that I am. I am tripped all the time, because I do not understand the situation." Well, now, that is what I meant by "ignorance." I do not believe we disagree if we clearly understand each other. But more and more as I grow older I say to myself, "Deeper study into the economies of farming, to prevent waste." My friend on the right (Mr. French) has given us a grand account of his stewardship, and long may he live!

Mr. Richards. I want to endorse what Governor Hoard has said in regard to ignorance. I most certainly think that is the trouble with the farmers. My two friends here both confess that in the past they could make money upon the farm, but they say they cannot do it to-day. The hour has passed for them. When they were young men they could say to the help, "Come, boys, let's go to work." To-day it is, "Go, boys, and do the work." The balance is against them. My friends, I think that in all the vocations of life nine out of ten of the people are following the wrong pursuit. Nine-tenths of the farmers are farmers simply because their grandfathers or fathers were farmers, not because it is the vocation they are best fitted to follow. It is only because it is a convenient vocation, that is all. Suppose a factory were started in my town of Marshfield, proposing to employ a thousand men. I venture to say that ninety-nine out of every hundred of the boys would get into that factory if they could, without regard to the question whether they are fitted to the vocation they are trying to adopt. I think, with Governor Hoard, that it is ignorance that is at the bottom of all these things. We do not cudgel our brains enough. I do not do much in raising squashes. I made a mistake in trying to do it this year, and have had to buy them for my family. The worms killed the squashes. I found that if I had investigated the subject a little further I should have learned how to kill the worms. I think a great many of the difficulties we encounter are wholly due to ignorance, and it would be better for agriculture if half the farmers were following some other business.

Professor Bailey. The last speaker has brought up a thought that was in my mind, and it is this; that, while in the olden times a good many of the older people here made money out of farming, they do not make money out of farming to-day very largely because the times have so much changed that farming is out of joint. I have so often seen this thing exemplified in various parts of the country that I cannot help speaking about it. I suppose you all know that every sort of business, every sort of profession has been obliged, during the last fifteen, twenty or twenty-five years, to make new adaptations, and fit itself to new conditions, new environments; and yet agriculture in all its branches, with a very few notable exceptions, is carried on upon the same basis that it was twenty-five years ago; and you will find that those very exceptions show that agriculture may still be made a profitable business. I can illustrate that very well from my own experience. My father is still living on the farm upon which I was born. The farm was devoted to two entirely different purposes. My father was a New Englander, and took very naturally to sheep and other stock. We were located near the Chicago market, on the eastern shore of Lake Michigan. As soon as I got old enough to take some interest in agriculture, our farming resolved itself into two distinct branches; one was stock raising and the other was fruit raising, which I undertook more particularly, and I am free to say it was profitable. There came a change in the condition of affairs along in the seventies. My father had grown older, and while, fifteen years ago, he made money out of that farm, to-day he barely lives. The fruit interest has very largely gone by, because he is not particularly interested in it. He finds the same condition of overproduction and lack of markets which has been mentioned here. But I am positive that I can find a score of young men in that town, of ages varying from twenty to thirty-five years, who are making money upon the same kind of farm that he is failing at the present time to make any money upon. They are simply fitting their business into the general competitive business of this age, while he, drifting on and becoming old, has let his farming opportunities slip by one by one, until he is no longer able to make any money out of the farm. Now, the fact that there are strong, bright young men, and men of middle age, who can make and who do make money on their farms, is proof to me that there is money yet to be made in farming; and the fact that there are others who do not make money is proof to me that somehow or other they are out of joint with these modern times.

The Chairman. These little bits of personal history are exceedingly interesting; but when the gentleman who preceded the last speaker told us that he lost his crop of squashes on account of the ravages of worms, it reminded me that the committee of arrangements have prepared another matter, which they think is of sufficient importance to occupy a little of the time of this Board. It is well known to the members of the Board, and I presume to every one in this audience, that there has been a persistent effort for the past two years to exterminate an insect pest from this immediate vicinity which has proved very destructive to all kinds of vegetation in Medford and adjoining towns. Although the committee of the Board of Agriculture appointed to take charge of this matter with a view to exterminating the pest are constantly at work attempting to destroy it, there is constant danger of the insect being carried beyond the limits within which they are working by passing teams or in some other way; and the fact that, both this year and last, almost every species of insect has been received with the inquiry if it is really the gypsy moth, shows that there is at present no knowledge that would be able to detect the first appearance of this insect in other parts of the Commonwealth. We have here to-day two of the committee and also Mr. Forbush, who has had immediate charge of the work under the direction of the committee, and we also have the insect itself, as prepared by Professor Fernald, showing it in its different stages of life. After a close examination of this insect, it would seem to be impossible that any one could mistake a true gypsy moth. We have two boxes containing the insects, which can be examined by each individual while we are considering the matter. Secretary Sessions, who is the chairman of the committee, will give a general outline of the work of the past season.

Secretary Sessions. As the chairman has said, it was felt by the committee of arrangements that this was a very important matter to the people of this State, and that the Board of Agriculture, as the work is now under its control, should understand more about it.

The gypsy moth, as I presume you all know from the accounts which have been published in the papers, came from Europe. A number of the insects were brought here more than twenty years ago by a Frenchman, who proposed to conduct some experiments in crossing them with silkworms. Unfortunately, a few of the insects made their escape, and remained in the lowlands and swamps about Medford for a dozen years, without attracting attention from any one. Then the people of that part of Medford began to notice their depredations, and made somewhat of a desultory fight against them, supposing they had only an American caterpillar to deal with; but in June, 1889, it had so far progressed into the uplands of Medford that the people became alarmed, and the town authorities took some measures to keep it down. Mr. John Stetson of Medford, who took a great interest in the public affairs of the town, had taken advantage of every possible opportunity to find out what the creature was. He could find nothing that was satisfactory in American books on entomology, and he brought specimens of the caterpillar into the office of the secretary of the State Board of Agriculture, to get information. We were as badly at fault as he was; our books gave us no information about it, and we sent the specimens to the Agricultural College, where the experience and skill of Professor Fernald and his assistants enabled them to tell us that it was the *Ocneria dispar* of Europe. Investigation followed, and we ascertained how the creature got here, and the damage that was likely to come from it. It was then too late in the season to do anything. The Legislature was not in session, and the town of Medford had expended all the money it thought advisable to save the shade trees for the time being. The caterpillars had passed through their transformations, and the eggs had been laid. No more damage would be done that season, and consequently action was delayed until the Legislature met in 1890. Then the Board of Agriculture, with others, by petition asked that some action be taken, and the Legislature provided for a commission to take this matter in charge, and appropriated $25,000. The commission was organized on the 22d of March, 1890. They worked through the spring of 1890, destroying great numbers of them, and in June called upon the Legislature for another appropriation of $25,000, which was granted. In February, 1891, this work was placed in its present hands, and a few weeks later it was put under the direction of the Board of Agriculture. So you, gentlemen, are really responsible to the State of Massachusetts for what has been done; the committee whom you have chosen have had this matter in charge. Your committee was organized March 4, 1891. The first thing they did was to call together the expert entomologists of the country for advice, headed by Professor Riley of the Agricultural Department at Washington, and Professor Fernald of the Massachusetts Agricultural College. They advised us that the only sure method of fighting the gypsy moth was by spraying with Paris green, and that the whole territory infested should be sprayed at the same time as nearly as possible. At that time the creatures were in the egg form only. The first thing to be done, of course, was to find some one to take charge of the work, for, as the committee were to serve without pay, they could not give their whole time to the direction of the work. We were very fortunate, as we believed and as experience has proved, in obtaining the services of Mr. E. H. Forbush. Professor Fernald of the Agricultural College was also engaged as consulting entomologist. The next thing was to procure help. Here was a territory of fifty to seventy-five square miles, infested by this creature, which must be gone over, and of course considerable help was required. It was necessary that we should have men that were interested, that we should have men who had some enthusiasm about the work, and would carry it on with intelligence and vigor. Men who could be hired for $1.25 or $1.50 a day would be of very little use to us, because this work which needed to be done thoroughly would be done by such men in a hap-hazard way. We could not go into the labor market and get such men as we wanted. We engaged as many men as we could in the vicinity of the territory who had had some experience the previous year, — bright men who were recommended to us by the town authorities; but we needed more help, and we made a draft upon the Agricultural College, and engaged some ten or twelve students, bright, smart young men, who had had some training in entomology. The first step was to teach them the habits of the creature, and where they were to look for them. They were set at work searching for the eggs, with a view to learning by experiment whether or not that would be an effectual method of eradicating the insect. At the same time they would be learning its methods and habits. Some comparatively small sections of the infested territory were thoroughly examined for eggs, and we are happy to be able to say that where it was thoroughly done scarcely any of the caterpillars appeared last season.

Next we were anxious to find out how far this creature had extended itself over the country, and we found by our investigation that they infested a much larger extent of territory than we had supposed. We found them in twenty-one cities and towns. The towns of Medford and Everett and the city of Malden were pretty thoroughly infested, and the belt of towns around those three places had more or less of them. We found some places that were badly infested and other places where they were few. But here was a territory of something like a hundred square miles that we had to look over. Arrangements were made for spraying with Paris green as soon as they should hatch out in May. It took a large force at an immense expense, as you may judge. We employed thirty teams, each carrying a tank containing one hundred and fifty gallons or more of water, and a double pump with two lines of hose; with seven men to each team. They worked through the season, which lasted until late in July, perhaps a trifle into August. We found in June that the money which was left from last year's appropriation of $50,000 (about $24,000) was quite insufficient, and we asked for an additional appropriation; and the Legislature gave us, without question, $50,000. That seems a large sum of money, but with three hundred men on the pay roll, thirty teams, office expenses, travelling expenses, and all the incidentals, this money is now very nearly exhausted. When the caterpillar turned into a chrysalis, and ceased eating, of course it was no use to spray longer with Paris green. Then experiments were made as to how they could be destroyed in that state. It was found that there were certain combinations that could be sprayed upon them that would kill them by contact. Something was accomplished in that way. Then they came into the moth stage, in which they remained but a few hours, or long enough to lay their eggs, and we had the rest of the season to work upon the eggs. Our experience in the spring in hunting the eggs on a limited territory had convinced us that it was feasible to fight them in that way, and our force was put to gathering eggs. We proposed to go over all this territory and thoroughly hunt and gather the eggs, but found that there was not sufficient money left of the appropriation to complete the work. We had found by observation that the creature had not occupied new territory of his own will, but had evidently been carried there by teams. The caterpillar does not migrate, he moves only in quest of food. He remains on a tree as long as the food supply is sufficient; when that is exhausted, he moves just far enough to get something more to eat. We found also that the female moth does not journey on the wing; so that the natural spread of the creature is very slow indeed. Outside the territory that was thoroughly infested, on the main roads here and there a centre of infection had been found, where, in a limited territory, they were quite numerous. Investigations proved that in almost every one of those cases we could determine almost to a certainty how they got there. They would be found in a field where manure had been drawn from the infested district. They would be found about the buildings of a milk peddler who had peddled milk in the infested section, going there every day and back to his farm. They would be found in places where people from the infested section had often been to visit their friends during the summer, and in picnic places where people had gone repeatedly back and forth. In every case we found that we could account for its presence outside of the circle of thoroughly infested territory where it had spread by natural causes. These facts are somewhat encouraging, because they lead us to the conclusion that the creatures are not outside of the territory which we have in hand, unless in some minor places where they have been carried by teams.

We, as I said before, attempted to examine this territory for eggs. One reason for doing so was this very condition of things. In the infested territory the caterpillars move in search of food. They are spinning down from the trees, crawling over fences, over the ground, onto horses and wagons and cattle, and there is continual danger from transportation. Now, then, we concluded that the spraying, while it killed millions of them, was not effectual to kill them all in any case, because of the fact that the eggs hatch at different seasons. (They begin to hatch as soon as we have warm days in the spring. Those that are exposed to the sun and in a warm place hatch quickly; those that are in some sheltered place hatch a little later; those that are under stones or in a stone wall, or in a cool, shady place, hatch still later; so that they are hatching from the 20th of April to the middle of June and even later.) Consequently, in order to kill them by Paris green, you must spray over and over and over again this entire territory, which is practically impossible. Now, then, the spreading, as we have proved to our own satisfaction, being by teams, we thought that must be prevented in some way, because otherwise they would be continually carried about, and we could never make any advance in exterminating them. We had tried policing the roads, employing men to examine every team coming from the territory where the caterpillars were plenty; but it was found practically impossible to stop every team and carriage and examine them, and we had to give that up. If we could reduce the numbers in the territory most thickly infested, so that this moving about for food could be stopped, we would prevent most of the danger from transportation by teams. But that is a tremendous job, owing to the fact that the eggs are laid in all manner of sheltered places, — in sheds, under buildings that are not underpinned, behind the boards of fences, under stones in stone walls, on trees and shrubs, and in every possible shelter. It is slow and expensive work. We find that there is not money enough left to do it. We believed it to be our duty to make sure that we knew to a certainty the utmost limits to which it had spread before our funds were entirely exhausted, so we have set thirty or forty men to examining the territory of the towns lying around the twenty-one towns in which we found the creature last spring. Our search for them at that time was largely after the leaves began to show themselves, which helped to cover the eggs, and of course we could not do the work so thoroughly as we wished. Now that the leaves have fallen, the men can more easily do this work of searching. We have not found any in Boston, but we do find occasionally here and there outside of the last spring limit little points of infection where they have been carried in some way, but nothing that seems to be discouraging. We have found, I believe, two little colonies in Marblehead; and two or three in Salem and Beverly. We are thoroughly examining the whole territory. You can imagine what a task it is to examine every tree and shrub in a township. That is what we are now doing, and we propose to have it finished when the Legislature comes together.

Now, Mr. Forbush is present, and, while I have attempted to give you an outline of what we have done and what we are attempting to do, he is more capable of answering any questions which you may wish to ask in regard to the habits of the creature than I am.

QUESTION. Has any parasite been discovered?

Mr. FORBUSH. We have discovered several parasites. We have found something like fifteen or sixteen insects (which are supposed to be parasitic) destroying the gypsy moth. They are all native insects so far as we know, and some of them are undoubtedly species unknown to science. Our native parasitic insects are feeding on the gypsy moth, and there will be probably no need of importing any parasites from France, Germany or any other country. Some that we have discovered are among the most useful parasites known in this country. We have the ichneumon, which destroyed the black moth in Maine at the time of its tremendous ravages some years ago. We have two or three others which are known to be very useful. They are common in Massachusetts, and can be easily obtained at any time. It is sometimes understood that all we need in order to exterminate an insect is to find and introduce parasites; but it should be generally known that parasites do not exterminate an insect pest. It is possible that they may reduce the numbers and keep it from doing harm for a series of years; but as the insect itself dies off its parasites naturally die, and sooner or later the insect will come to the front. In Europe, where the parasites of the gypsy moth are numerous, it is still a serious scourge. It is said to have spread through central Europe, Asia, and throughout Japan, and it will undoubtedly be a tremendous scourge here if it is allowed in any way to spread.

Mr. Lynde. I understand, from what the secretary says, that there is a liability of their being carried on cars if they are carried on teams.

Mr. Forbush. There is some liability of the insect being carried by rail, but the country in which it is found has communications mostly with Boston, and it is very unlikely that they will be carried any great distance except on people going back and forth. Let us suppose that two caterpillars are carried out on the person of one of these gentlemen here, if he is in the infested territory at the time when caterpillars are crawling. In that case the chances of their both being dropped at the same place are very few. The probability is, of course, that they will be widely separated; and it is better to have one worm alone in the western part of the State than here, because we are certain it will never produce any progeny there; but while here it may, because the male will find the female, if within a certain distance. We have followed up many clues outside of this section, where we had reason to suppose they would be carried; but we have not found them except in the towns right about here.

Question. Have you entirely exterminated it from any part of the infested district?

Mr. Forbush. That is exactly the question I want to answer. I can say that, as far as it is in the power of man to determine, we have exterminated the insect in many different places; that is, small colonies. I think in every case we have done it by gathering the eggs, and by that alone. We have tried spraying and a good many other means to kill the caterpillars, and some of them have been effective to a certain degree; but those means will only serve to prevent their increase. When the time comes for gathering the eggs they can be plainly seen on the apple trees and wherever they have been laid; no man can help seeing them who is looking for them, and all we have to do is to go and gather them. We have found instances where we have entirely exterminated them, working with our imperfectly trained men, the first season. Now, if we can do that in one place we can do it in all, provided we can find the men. In your crop reports I see that farm help is scarce and high. Good gypsy moth help is scarcer and a good deal higher. We want bright young men; men whom we can teach, if possible; men who have been trained to habits of close observation. If we can secure such men, they are the men who will make good gypsy moth hunters; but, unless we can get that kind of men, we can never exterminate the moth. We can never do any more than keep the numbers down. If we can get enough of such men, and money enough behind them, I surely believe we can exterminate it. But the question of cost is a great one.

Mr. Edson. Can you give us any idea of the quantity of eggs they lay?

Mr. Forbush. I made an estimate of the first six weeks' work. We did not count the egg-clusters then; we gathered them by quarts and estimated them by the quart. I estimated the quantity gathered and burned as something like eight cart-loads. Some of the territory that we did not go over last spring we have been over this fall. I should say that we had gathered several cart-loads of eggs there. The eggs of the gypsy moth, where they are few, are usually found on the trunks of trees, and on the under side of branches, in holes and cavities in the trees. Wherever they become abundant, like most other insects, they deposit them everywhere. They are then found on fences, in cellars, in unoccupied rooms, in all sorts of places, — even inside of chimneys and under the eaves of houses. These are the places where we have the greatest trouble in finding them. People say, "When they get into the villages you can hunt them and get rid of them easily;" but it is not so. When they get into the woods we can get rid of them, even if we have to destroy the trees; but if they get into the villages we cannot tear the houses down unless the State pays for them, and I do not think the State would be willing to pay for them. There is no other way but to hunt for them year after year until we can get them all.

Mr. COLE. Is there any one kind of tree that the gypsy moth prefers to feed upon rather than any other? I would like also to ask if there is any danger of those gypsy moths that are hatched in bed-rooms and cellars getting enough to eat there to bring them to maturity?

Mr. FORBUSH. I do not think there is any danger of their getting food in any of those places, but they seem to feed somewhat on the egg shell or what is left of the egg. The young caterpillars have considerable strength, and they will live some days without food, and if there is any chance to get out they will escape. They will go through any opening and go onto the first plant they come to; and if they cannot get something they like they will take something they do not care so much for. We have found them in the bottom of boxed fences, where we thought they could not get out; but when we came around shortly afterwards we found them crawling through little pin holes and getting out and going up trees. Now, in regard to the kind of food that they eat. We have kept them down so that they have not done any damage to amount to anything except in two towns, Arlington and Swampscott, where in two places they did considerable damage. We continued our spring inspection until the caterpillars came out, and we followed them until they got quite large, — they must be of some size before most men can see them, — and we found they were eating anything they could find. The gypsy moth is not at all fastidious in its taste. Any kind of tree or plant is good enough for it In those places in Arlington and Swampscott they ate everything. They ate barberry bushes, they ate apple-tree leaves, they ate pine and Norway spruce, and when they got hungry and could not find anything else to eat they would eat grass. So that you see we have here an insect that is more dangerous tnan the tent caterpillar or the canker worm, which usually attack only one or two species of trees. You can tar the trees and catch the canker worm, and you can destroy the nests of the tent caterpillar very easily. The gypsy moth feeds by night. You cannot go around in the night and hunt him with a dark lantern, although we have had to do that to learn something of his habits. So you see how dangerous the creature is. But if the farmers will destroy the eggs they will then check the insect. There is a whole colony of from five hundred to fourteen hundred eggs right in one cluster. Take the cluster off in your hand and burn it, and there is an end of them. That is the only way in which we can effectually destroy the gypsy moth.

QUESTION. On what kind of trees do they lay their eggs, and how far from the ground?

Mr. FORBUSH. You find them usually about eight or ten feet from the ground, but where they are plenty I have known them to go up ninety feet, clear out to the ends of the twigs on the largest limbs. There we have to get at them by shooting off the twigs, if we cannot climb to them.

QUESTION. What is the prospect for next year?

Mr. FORBUSH. When we went through the infested territory last year, even with the limited knowledge that our men then had, it was very easy to see eggs on the trees; to-day it is very hard to find them. The probability is that next year, if we have men enough, the moths will only appear in places where it is now impossible to get at their eggs; and, with the experience that we now have, I think we can eradicate them. Comparing the numbers that we found last year with the numbers we find now, I should say our spring and summer work had disposed of about ninety per cent of the insects. That is, we have disposed of the increase, and there were only ten per cent as many found when we went through the territory this fall as were found last spring.

Secretary SESSIONS. Then the question of success or failure depends entirely upon the appropriation, because the money has almost all been spent?

Mr. FORBUSH. It certainly does depend upon the appropriation. There is no great work which can be accomplished without money. I do not want to say where the moth is, or where it is not. I do not think it is easy to do that just yet. My opinion is that there may be a few isolated colonies here and there outside the known territory, and there are fifteen or twenty towns in which the insect may be found in small numbers. We expect to find it in other places, but we do not expect to find enough to make the work of extermination there very difficult. The main expense will be incurred in finding the eggs.

Governor HOARD. Do they fly by night?

Mr. FORBUSH. They do not fly late at night, they fly by day. Thus they are not attracted to light, as all night-flying insects are. The female does not fly at all. I will not say that she *cannot* fly, because she has plenty of wings to fly with, but she *does* not. We have never known one to fly. The main function of the insect in the moth stage is to reproduce its kind. It does not feed. Its digestive organs are atrophied, and it is not attracted by any food. The only way we can attract the males is by exposing females in localities where males are known to be.

QUESTION. Does the commission experience any inconvenience from interference with its work?

Mr. FORBUSH. We have not experienced any serious interference, but on one or two occasions we have been attacked by people. One young man had trouble; an old lady thrust a rake at him as he was climbing up into a tree. At another time our men were assaulted by a man, and we had to bring the case into court. There are, however, a great many people who do not believe in the work; but when we go into the country among farmers they want us to go into their orchards, and spray their trees, whether there are any gypsy moths on them or not. They appreciate the work we are doing. They have had to fight these insect pests all their lives, and they do not want to have another get into their orchards.

Mr. LYNDE. I think it would be a good thing to have the statement that has been made to us published, so that the public may know more about this insect. I have obtained more information from what has been said here to-day than I have ever had before.

Mr. FORBUSH. I am very glad to have you bring up that point. We have, I think, some two hundred written pages in regard to the habits of the gypsy moth. I have studied it by day, and I have had a man go to a tree and stay there twenty-four hours without going away. We know just what it is, and we know its habits quite well. A man must know them in order to get at them and destroy them. The habits and transformations of the insect would make a very interesting book. Now, I want this Board to have these things published in some way. If it can be done I think it will be of great benefit to the farmers. We are now having prepared a plate containing a series of the transformations of the insect from the egg to the perfect moth, and that is to go in with our report to the Legislature. I hope that a report will be printed for general distribution. I have been trying to impress upon the committee that this is what they ought to do. If this insect ever gets away you will have to fight it, and it will get to your farms very soon, if it is not kept within its present limits.

Mr. LYNDE. We must all go home and write to our senators and representatives to vote for an appropriation for the destruction of the gypsy moth.

Mr. FORBUSH. I agree with you heartily. Perhaps it is not generally known that at the last convention of the Entomological Society at Washington it was stated that $31,000,000 were lost every year by the people of this country through the ravages of insects.

Governor HOARD. The chinch bug cost the people of Illinois $73,000,000 in one year.

Mr. FORBUSH. That is confirmation of the statement I have just made. Now, we have spent nearly $70,000 in one year in fighting the gypsy moth. We hope we shall not have to use as much another year; but, if the gypsy moth is allowed to spread, the farmers of this State will lose a great deal more than that. The lowest estimate by Professor Fernald of the damage caused by the potato beetle *annually* in Massachusetts is $75,000, even now when the farmers know how to handle it. The gypsy moth, which feeds on so many different kinds of trees and plants, will certainly cost a great deal more here in Massachusetts if it is allowed to spread. Think how much will be saved to the nation if it can be kept from spreading, as I believe it can be. I believe that if the people will stand behind us and give us money enough to fight it, we can hold it back and even exterminate it; and how much money and trouble will be saved to the farmers of the country if we can do this. Let us have money enough and men enough to fight it. Let us teach the farmers' boys how to fight it, and to hit a head every time it shows itself.

Mr. BOWKER. If it is not too late, I want to call the meeting back to the paper which was read, as we have a gentleman here who can tell us something of what has been done in one of our sister States. I refer to Dr. Twitchell of Maine.

Dr. G. M. TWITCHELL (of Fairfield, Me.). Mr. Chairman and Gentlemen: The hour is late, and there is no time for any extended remarks to-night. I felt when Governor Hoard was talking as though I would like to say a word, but the discussion drifted off into another channel. The Maine State Grange a few years ago took up this subject of agricultural education, raised a commission to thoroughly investigate the subject, and authorized the preparation of a work on the "Science of Agriculture." Fortunately we have among our local force a graduate of Brown University, the former principal of one of our high schools, who has gone back upon a farm and is doing a grand work. We put him in charge of the matter. The book was published by a Chicago firm this past season, and all through the summer you would have been astonished to see how our educational men were tumbling over each other in their anxiety to get that book into the schools. They seemed to think that that was the only way by which they could save agriculture in the State of Maine. But really it is a valuable little book, meeting the case. Professor Stetson of Auburn, the superintendent of schools in that city, told me the other day that he had about forty teachers under his care, and he hoped that he would be able during the year to interest three or four of them and get them at work upon the subject in an intelligent manner; and if he did he should feel that he had been successful in doing something towards enlarging the common course of study, and something for which the teachers must be specially fitted. But the work has been taken up in several of our towns, and at the present time our State superintendent of schools is urging the adoption of the book whenever opportunity presents itself, so that another year a good percentage of the common schools in Maine will be using Professor Winslow's little work on the "Science of Agriculture."

QUESTION. Have you seen the one published by the Indiana Agricultural College?

Dr. TWITCHELL. I do not think I have seen that work, but I understand it is quite a large book. This work of Professor Winslow's is a comprehensive little volume. I am very glad to be able to say that Maine has taken up the work. I will not take any more of your time to-night, gentlemen; it is too late.

Adjourned to Wednesday, at ten o'clock.

SECOND DAY.

The meeting was called to order at 10.15 by Secretary Sessions, who said: —

Gentlemen, the committee of arrangements have arranged that a gentleman who is particularly familiar with the subject for discussion this morning should preside; therefore I call Mr. E. F. Bowditch to the chair.

Mr. Bowditch. Gentlemen, the subject of the lecture this morning is the "History of Sheep Husbandry in Massachusetts;" and the gentleman who is to give you the paper is not only one of the pioneers of sheep husbandry in Massachusetts, but he is an encyclopedia of information on sheep husbandry all over the world, and one of the oldest and most useful members of the Board of Agriculture that the State has ever had. I have great pleasure in introducing Mr. James S. Grinnell of Greenfield.

HISTORY OF SHEEP HUSBANDRY IN MASSACHUSETTS.

BY HON. JAMES S. GRINNELL OF GREENFIELD.

The subject of sheep husbandry, always one of the greatest importance to the whole farming community, seems again to be exciting general interest and attention in our State, and, in the opinion of the Board of Agriculture, would be aided and advanced by a somewhat extended consideration in a paper which I was directed to prepare and bring before this meeting, and by the full discussion which is to follow.

In all ages the sheep has been a prominent representative of rural husbandry, profitable and eminently respectable, from the time that Abel, the first keeper of sheep, made to the Lord an acceptable offering of the firstlings of his flock — early lambs; and many hundreds of years later that great farmer and flock-master, Job, reckoned among his stock fourteen thousand sheep.

Originally neither the flesh of the sheep nor of any other animal was used as an article of food. According to Biblical history, only a vegetable diet was permitted, — the fruit of every tree in the garden of Eden (with one exception) "and every herb of the field;" so that for about sixteen hundred years, till after the deluge, no sheep were killed to be eaten. It was only after Noah had stepped forth from the ark and offered his sacrifice that the Divine permission was given, "Every moving thing that liveth shall be meat for you; even as the green herb have I given you all things." From this time on the flesh of the sheep was not only an acceptable offering to the Almighty, but as an article of food is frequently mentioned in Holy Writ, from the dressing of a single lamb in very early days down to the magnificence of Solomon, who, besides his established character for wisdom generally, manifested an exceeding good taste and consideration for his household by having a hundred sheep slaughtered for their daily maintenance and enjoyment.

Sheep probably found their way into Europe by the Hellespont with the early civilization of its inhabitants, and after a long interval into Italy; they were early cultivated in Spain, having probably been introduced there from Africa long before the founding of Rome. The more northern part of Europe was a great forest, unfavorable to the growing of sheep, and their numbers seem always to have been small. The Celtic tribes paid more regard to the ox than to the sheep, and the flocks of the early inhabitants of Europe never equalled those of the Syrian and other Asiatic shepherds.

As the sheep of this country (except the Merinos) mostly came from England, it would be curious and interesting to trace their introduction to that country. Unfortunately this is shrouded in the darkness which envelops the British Islands prior to their invasion and conquest by the Romans. During that dynasty, however, wool was spun and woven and woollen fabrics were made in Britain; and in course of time the woollens of Winchester, which were said to rival the spider's web in fineness, attained the highest reputation, and maintained it for centuries; but there is no record of the sheep from whose fleece these were spun and woven. It is believed that the Hibernians had from the Phœnicians acquired the art of spinning and weaving long before the invasion of the Romans upon England, and while the people of the larger island were still clad in the skins of wild animals, and of oxen and sheep, after their untraceable introduction. From that time to the improvement of sheep and the settlement of this country is a long interval. Either the sheep were not very early introduced here, or the chroniclers of that day did not see fit to make any special mention of them; horses, cattle, and, strangely, goats, are much earlier and oftener noticed than sheep.

In 1629 permission was given to ship from Southampton one hundred and forty cattle, horses, sheep and goats; how many were landed, if any, does not appear. July, 1631, from Barnstable in Devonshire were shipped eight heifers, a calf and five sheep. June 15, 1633, thirty-four

Dutch sheep were landed, forty having been lost at sea. In the same year these or others are recorded as having been carried onto an island in Boston harbor as a place of protection against wolves. In 1635 eighty-eight Dutch ewes were brought in, valued at fifty shillings each. July, 1633, an order was made that no sheep should be exported. May 14, 1648, the following order was made by the General Court: "that forasmuch as the keeping of sheep tends to the good and benefit of the country, if they were carefully preserved, henceforth it shall be lawful for any man to keep sheep on any common, accounting five sheep to one great beast. And if any dog shall kill any sheep, the owner shall either hang his dog forthwith, or pay double damages for the sheep. And if any dog has been known to course or bite any sheep before, not being set on, and his owner had notice thereof, then he shall both hang his dog and pay for the sheep."

In 1634 an order was passed by the court: "that whereas, the country was in great straits in respect of clothing, and the most likeliest way tending to supply in that respect is the raising and keeping of sheep within our jurisdiction, it is therefore ordered and enacted by this court, that after the publication hereof no person or persons whatsoever shall transport any ewes or ewe lambs out of this jurisdiction to any foreign place or port, upon the penalty of the forfeiture of five pounds for every ewe or ewe lamb so transported."

In 1652 Charlestown had as many as four hundred sheep; and in 1658 John Josselyn wrote, in the account of his two voyages to the Colonies, of there being eight hundred at Black Point in this State, and again mentions their having great store of sheep in the colony.

Twenty years later, Sir Edward Randolph, commissioner of the Crown, wrote in his official correspondence that "New England abounded in sheep." By successive importations, care in breeding and preserving, forbidding exportations and the killing of sheep as much as possible, they multiplied greatly, they became abundant on the commons, and were watched and guarded by a shepherd. Herding, now so successfully practised by the most eminent sheep grower in the State, was first used in this country in Rowley, where permission was granted to erect sheep gates, or lengths of movable fence to be set up at night as protection against wolves and dogs.

Clothing.

Next to food and shelter, the great exigency of the early settlers was of course clothing sufficient not only to cover their nakedness, but to keep them warm in this cold climate. In this respect, as in some others, they were content to receive from the customs of their barbarous neighbors suggestions which were not without use to them in their peculiar circumstances. The original clothing of the Indians was from the furs and skins of wild animals. Much skill was evinced in the dressing of buffalo, deer, elk and other skins for that purpose; for external wear they were prepared with the hair or wool on, and for under garments the smaller skins were made into a kind of "chamois" leather by removing the hair and dressing them with the brains of the animal, which rendered them very soft and pliable. A squaw would thus prepare eight or ten skins in a day. Morton says the Indians "made their skins into very good leather, making them 'plume' and soft; the moose skins they commonly dress bare and make them wondrous white; the moccasins and leggings were usually made from the moose skins." The colonists made much use of these materials, which comported well with their rugged mode of life and the severity of the climate. Indeed, they were not unaccustomed to the use of similar materials in their native country; for in England, even in that day, leather dressed as buff and in other styles, and worn as doublets, breeches or vests, formed no inconsiderable part of the clothing of some classes, and for some purposes was worn by the nobility. These sober and frugal materials continued in use till after the era of independence, and garments wholly or in part of buckskin or other leather could be found in the wardrobes of even the wealthy men of that day. Deerskins dressed were then worth from three shillings and sixpence to seven shillings each.

In 1747, Joseph Calef, a leather dresser of Charlestown, was robbed by burglars, who took a variety of sheepskins dressed for clothing, some cloth colored for breeches very much upon the red, others were cloth colored thin skins for gloves. In the "Boston Evening Post," February, 1748, are advertised "two fulling mills for the fulling of leather."

As fast as the settlers could produce the materials and provide the men and means, they had spun and woven for clothing flax of their own growing, the cultivation of which they had commenced early; cotton from Barbadoes, and wool imported from Malaga and some other ports. All these textile goods for more than a hundred years were spun and woven and dyed in the homestead; every house had a spinning-wheel, and every other house a loom. The price of spinning worsted or linen we are told was usually two shillings per pound; for knitting coarse yarn stockings, half a crown a pair; for weaving linen half a yard wide, ten to twelve pence per yard. The cost of manufacturing eighteen pounds of wool into twenty yards of cloth was $21.24, or $1.06 per yard three-quarters wide. In the earlier days very little cloth was on sale, it was largely consumed in the family or used in barter with the neighbors for other necessities; and almost the only attainable way of getting at a price is to read some dead man's inventory. In 1671 worsted was worth sixty-six pence per pound, and woollen thirty-two pence. Much linsey-woolsey was made for men's wear, of linen warp and wool filling, valued at eighteen cents per yard. Homespun garments or cloth were seldom inventoried; a piece of homespun is valued at three and sixpence in 1681, justifying a statement of a letter writer of that day, that in 1675 "there is no cloth made worth four shillings and no linen over two shillings and sixpence per yard;" perhaps not, but it covered a race unsurpassed for bravery and fortitude. I might perhaps truthfully say that they were men of great understanding, for among the outfits provided for the colony in 1629, "a great store of shoes is ordered of neats leather of sizes from ten to thirteen."

Domestic manufactures began early, especially spinning and weaving; for in 1639 home-made cloth is found in Peter Branch's inventory, and appears in increasing quantities, though probably insufficient to keep pace with the increasing population, for in 1640 a bounty was offered for home-made cloth. In 1656, finding the supply still short, the selectmen were ordered to assess on each family the spinning and weaving of a certain amount of cloth. This cloth was woven on hand looms, as was all the cloth of every kind made in England as well as here; for it must be remembered that the power loom was not in existence, — it was invented by Rev. Edward Cartwright in 1788, and perfected by him in 1790.

The first fulling mill for dressing this home-made cloth was built at Rowley in 1643 by a company of weavers, skilled workmen from Yorkshire, under the spiritual and business charge of Rev. Ezekiel Rogers, where the first woolen cloth was dressed in New England. Another fulling mill was erected in Salem about the same time, and soon after they became common. The price of this home-made cloth was six or eight shillings per yard, imported cloth fifteen to eighteen shillings.

In 1657 the value of a sheep was one pound, an ox five pounds, horse ten pounds, cow three pounds, wool eight pence, negro boy twenty pounds. A story which I came across in preparing this paper, though not entirely pertinent, will not be displeasing to you, as illustrating some of the trials of this early colonial life. In the latter half of the last century lived a small family on a stony farm in Connecticut. The stock consisted of a dozen sheep and a cow, who, besides her yield of milk, added her services on the plough; corn bread, milk and bean porridge were the staples of their diet. The father being incapacitated by long illness, the mother did her work in the house and helped the boys in the fields. Once in mid-winter one of the boys needed a new suit, and there was neither money nor wool in the house. The mother sheared the half-grown fleece from a sheep, and in a week it was made into clothes for the boy. The shorn sheep, so generous in such need, was protected from the cold by a wrapping made of braided straw. They lived four miles from the meeting-house, to which the mother and her boys walked every Sunday. Those boys became the Rev. Samuel Nott, a famous preacher, and Rev. Dr. Eliphalet Nott, the President of Union College.

Our ancestors emigrated from different places in the United Kingdom, and some from the various countries of

Europe; they brought with them domestic animals and their implements of husbandry to subdue and cultivate the wilderness. Each, as would be natural to suppose, made choice of the favorite breed of his own immediate district to transport to the new world, and the admixture of these breeds formed the mongrel family known as native sheep; amid the perils of war and the incursions of wild beasts of prey these were preserved with attentive care. The descendants of these sheep, known in our day as "native" in distinction from the breeds of recent known importation, were of two types,—one with white faces and the other with dark or spotted faces and legs. These last were known in the Connecticut valley and through the Western part of the State as "English runts" or "Irish smuts," and were undoubtedly taken from the counties lying on the south coast of England, Devon, Hampshire and Sussex, and were the same stock of sheep from the Downs of Sussex and Hampshire, that in later years, under the care and skill of John Ellman, Jonas Webb and others, became the matchless "South Downs."

A very convincing proof of this occurred in my own experience. Some thirty years ago or more, when Mr. Fay imported the Oxford Downs, I had from him a large superior ram which I coupled with fifty of the Irish smut ewes picked up for me by a friendly drover in the Western part of Franklin County and Southern Vermont. The product was marvellous; I had succeeded in obtaining what horse men would call a perfect "nick." The type of the lambs, several of which were twins, was entirely changed from that of the ewes, and seemed to assume the character of the improved South Down in the Oxford Down ram; shortened the neck, colored the faces uniformly brown, widened the breast, shortened the legs, put on more wool, sprung out the ribs, deepened and broadened the hind quarters, and gave them a weight of seventy-five pounds in ninety days. So I believe the old South Down blood was in our "native" sheep, and only needed developing.

The larger white-faced, long-legged, bare-legged, light-fleeced sheep of the country were originally brought in considerable numbers from the Texel and other parts of Holland. These common sheep gave a wool only suited for coarser fabrics, yielding in the hands of good farmers a fleece of not over three and one-half or four pounds. They were slow in arriving at maturity, compared with the present improved English breeds, and yielded when full grown only from twelve to fourteen pounds per quarter of a middling quality of mutton which, however, was in but slight demand; they were usually long-legged, light in the fore quarter, and narrow on the back and hind quarter. They were hardy, easy keepers and good breeders, often rearing, almost entirely destitute of care and shelter, one hundred per cent of lambs, and in small flocks with more care a still larger proportion; these were dropped in March and April. Restless in their disposition, their impatience of restraint almost equalled that of the untamed sheep of the Rocky Mountains; and in many parts of the country it was common to see flocks of from twenty to fifty roaming with little regard to enclosures over the possessions of the owner and his neighbors, leaving a portion of their wool on every thorn and bush.

I do not purpose to give a history of the different breeds of sheep cultivated in England, but briefly to notice those that have received the preference of our own farmers.

South Downs.

Seventy-five years ago there were in the United Kingdom of Great Britain twenty different so-called breeds of sheep, each peculiar to the county or circumscribed district in which they were bred, and many of them probably not breeds in the strict sense of that term, as capable of reproducing their own type under all circumstances. Many of these have been absorbed, and are disappearing by cross-breeding with the more profitable breeds; of these, the one having undoubtedly the most influence has been the South Down, which has stamped its characteristics on the popular families of the Oxford, the Hampshire and the Shropshire Downs, now, with the exception of some Merinos, almost exclusively bred in this State.

The chalk hills called downs, running through the county of Sussex and into Hampshire on the south coast of England, are the home of the South Downs, now so famous all over the world, not only for themselves, but as fixing their characteristics on every breed upon which they have been crossed; and this they owe to the prepotency of their blood, conducted down unmixed for nearly a thousand years.

But the South Downs were not always what they are now; a little more than a hundred years ago an enterprising sheep owner, Mr. John Ellman, commenced the improvement of the South Downs by selecting judiciously and breeding most carefully. This was afterward continued with equal skill by Mr. Jonas Webb, who with others has brought these beautiful animals to their present perfect condition; their pleasant brown faces, their broad, straight backs, their deep briskets and splendid legs of mutton are everywhere known. For this part of the country they and their congeners, the Shrops, the Hampshire and the Oxford, are the most valuable and popular sheep we have.

Hampshire Downs.

From the South Downs, bred on the old white-faced horned sheep of Hampshire and Wiltshire, came the grand Hampshire Down; but the strong blood of the South Down has done away with the horns, and given them its own dark face. They are large, heavy sheep, producing splendid hardy lambs, with a good fleece and an admirable leg of mutton; and they, as well as all the Downs, impart their characteristics wherever used.

Shropshires.

The Shropshires were produced by breeding the South Downs on the small, dark-faced horned sheep of Shropshire on the border of Wales; the size was improved by a cross or two of Leicester, and reverting to the South Downs, who have taken off the horns, and made them one of the most popular breeds in England and in this State, bearing all the excellent characteristics of the Downs.

Oxford Downs.

The Oxford Downs were large and white-faced; but under the influence of the South Downs and the Hampshire Downs, and with an occasional dip into the Cotswolds to add to and keep up the size (which has been done with all these breeds improved by the influence of South Down blood), they have become grand sheep with a good fleece, heavier than the Cotswold and somewhat finer; they are very likely to drop twins, and are very capable of raising them. All of these Down sheep are worthy of our attention and care.

Leicesters.

The original Leicesters were large, coarse, inferior animals, till Robert Bakewell, something over a century ago, commenced their improvement; and by care, selection and breeding steadily for one purpose, he made them the best mutton sheep in the world at that time, not caring whether they had any wool or not. He bred them so close and so fine as greatly to impair their constitution. They are not suited to our climate and general treatment as pure-bred animals, but our native sheep were years ago improved by a cross of Leicester for size.

Cotswolds.

The Cotswolds came from the county of Gloucester, early noted for wool production; its sheep were so highly prized that four hundred years ago a number were exported to Spain by royal permission. They are remarkable for size and symmetry, and are of an imposing presence. The head is large, without horns, carried high and well wooled, with a large forelock hanging over the face; the face and legs are white, occasionally slightly mottled with gray or dark brown; the wool is long, wavy and lustrous, sometimes measuring eight to ten inches, and commands a high price; the quality of the flesh, — though not equal to the Downs, — their great size and good shape make them desirable especially to cross on other breeds when increased size is desired, and they have been used for that purpose in this State.

Dorsets.

Another breed which is attracting considerable attention in this country at the present time, and has long been popular in England, is the Dorset. From time immemorial these sheep have been naturalized in the county of Dorset, and formerly extended over a large tract of country.

These sheep possess small horns common to both male and female; they have white faces, and legs which are somewhat long but fine, showing a very good breast and a fine leg of mutton with loins broad and deep; wethers will fatten to twenty pounds to the quarter. They are a hardy race of sheep, docile, and capable of subsisting on scanty pastures; their mutton is good, and they shear six or seven pounds of close wool, finer than the Downs.

The property of the Dorsets which remarkably distinguishes them is the fecundity of the females, and their readiness to receive the ram at any season. This, and their capacity for yielding an abundant supply of milk, renders them particularly desirable for raising early lambs. In England they have been largely and profitably used for raising lambs for winter use even as early as Christmas, and called "house lambs," for which in London there is a great demand. The lambs are hardy, thrifty, mature early, and will dress twenty-eight to thirty pounds at sixty or seventy days old. Probably a cross of a South Down ram on Dorset ewes would give more size and early maturity with the superior nursing quality of the dam. They tend strongly to twins, sometimes having triplets, and their full flow of milk suffices to raise the lambs. Some sheep farmers think one lamb for a ewe is better than two; but if the ewe is a good milker, and well fed, twins are profitable. Mr. Youatt says, "If a farmer has feed enough and good enough, twins are highly desirable." An old English couplet, written before the first sheep was landed in Plymouth colony, says: —

"Ewes yearly by twinning rich masters do make;
The lambs of such twinners for breeders go take."

Merinos.

The breed of sheep, however, which in its production of fine wool has been the most important in the history of the world, is the Spanish Merino. Long before the Christian era the finest garments worn by the nobility and wealthy citizens of imperial Rome were woven from the fine wools of Truditania, Andalusia and Estramadura in Spain. Subsequently the original Spanish sheep were raised and improved by the Moors, who brought with them into Spain fine sheep from North Africa, which they had carefully cultivated, and from whose fleeces were woven fabrics of superlative quality.

The fine sheep of Spain a hundred years ago numbered over twenty millions, and were long preserved as a monopoly with jealous care. Sweden has the honor of being the first country which secured a flock of these coveted animals. France, though adjoining Spain, obtained none till near the close of the last century. In 1765 the Elector of Saxony succeeded in securing a flock, which, crossed on the native fine sheep of his kingdom, and carefully bred, made the Saxonies so famous for the fineness of their wool here sixty years ago. The skill and ability with which the Spanish Merinos were bred and cultivated in this part of the country were convincingly shown at an international exhibition in 1861, at Hamburg, Germany, when American Merinos, bred by George Campbell of Vermont, and exhibited under the direction of Col. Daniel Needham, formerly of our Board, captured the prizes and defied competition.

Saxonies.

The Saxonies were first imported by Samuel Henshaw of Boston, and much was anticipated from the introduction of these sheep producing such superlatively fine wool. When they were introduced, in 1823 or 1824, they were much smaller and of a feebler constitution than their parent stock, the Spanish Merinos; the wool was from an inch to an inch and a half long on the back and sides, and a washed fleece weighed only about one and three-fourths pounds. Attempts at improvement by crossing with the Merinos were made in vain; both deteriorated, and before 1850 the Saxonies had mostly gone out. They have been lessening in number greatly ever since, and, although we nominally have about a thousand, I doubt if there is a genuine, pure-bred Saxon in the State.

From the long-established policy of the British Government in encouraging and fostering the manufactures of that country and of discouraging and even forbidding any attempts toward it in her colonies, we found ourselves, at the close of the war of the revolution, not only without the manufactories of woollens, but also destitute of the material from which to make such fine goods as were necessary. The attention of our statesmen was early directed to supply this deficiency, and they wisely looked to the Merinos of Spain to accomplish it; but it was with the greatest difficulty that the Spanish Government could be persuaded to allow any of them to be exported.

The first important importation of these was made by Col. David Humphreys of Connecticut, then United States Minister to Spain, who brought a flock of about one hundred to his farm in Derby, Connecticut. These increased to such an extent that he made at his mill in 1807 several hundred yards of fine cloth. In 1809 President Madison was inducted into office in the first inaugural suit of American broadcloth, the coat from Colonel Humphrey's flock, the waistcoat and small clothes from the flock of Mr. Livingston of New York. Arthur Scholfield wove the first piece of fine broadcloth that was ever made in this country from Merino wool, at Pittsfield in this State.

The most important early importation, however, was by Mr. William Jarvis, American consul at Lisbon in Portugal, who seized an opportunity to buy some of the finest sheep in Spain, the confiscated property of some wealthy nobleman, and sent to this State and to different parts of the country about thirty-eight hundred fine Merinos, the most and finest ever exported. These and others, distributed over all the States bordering on the Atlantic coast, soon changed the character of the wool and wool growing of the country.

It is not strange that we of Massachusetts should have taken the lead in this industry of wool growing and wool manufacturing as we did in every matter advancing the material or the intellectual progress of civilization. The first sheep producing the desired quality of wool for making fine cloth were either landed on our shores or brought directly within our borders, where they were cared for and multiplied amazingly. There were then no Western States; Ohio, which has since assumed the lead in sheep raising and in sheep legislation, had just received her baptismal nomination; all the sheep, all the implements of manufacture, — such as they were, all the men of character and industry, were this side the Alleghanies.

The men who planted themselves on the coast of Massachusetts Bay came not only for religious freedom but to speedily build themselves homes with such necessaries and comforts as they enjoyed in the homes they had left behind them, by laboring at the same occupations at which they had wrought in England. The list of trades and those who worked in them would astonish one, from glass workers to needle makers; the names of Joseph Jenks, John Pearson, Edward Gibbon, Israel Stoughton and others who started manufactures should be kept in perpetual remembrance.

Our climate is admirably adapted to sheep growing, one proof of which is that in no country are sheep so little liable to disease as in New England. Our rough hills covered with sweet herbage from which all superfluous water disappears about as fast as it falls, and our sharp, dry winds, are naturally adapted to the wants and conditions of sheep, which always thrive best in the purest and most bracing atmosphere. Wet seasons and wet soils are destructive to sheep. The New England flock master is forced to recognize what the English sheep raisers were long in learning, — the economy and benefit of shelter in winter, even in their less rigorous climate. The truth is that sheep in New England, if well sheltered and furnished with proper food, will produce better wool and mutton and a larger increase of lambs than sheep exposed, even in the genial climate of Virginia. Sheep are most indiscriminate feeders, and delight in a change of food. One who takes the pains to observe them when feeding will be surprised at the continual shifting they make from one species of herbage to another, and upon our hills and valleys there is to be found the full variety which their nature requires.

The first mill for weaving and finishing fine cloth was at Pittsfield, run by Arthur Scholfield, a weaver from Yorkshire, who settled here and made the first broadcloth, fine enough for any gentleman's wear at that time. Several hundred yards of homespun were annually dressed at Rowley and Salem. That there was abundant wool of common kind widely distributed is shown by this fact, among others, that in the first years of this century two thousand pairs of hand-knit stockings were annually exported from the Island of Martha's Vineyard.

On the 15th of November I addressed circulars containing a few interrogatories to various men in the State whose names were given me as sheep raisers, to the number of about a hundred. I have been much gratified at the full replies made, of which I have received over sixty, for which I beg to thank very heartily the senders. I intend if possible to tabulate the results, and to have them presented to the public at some future time.

The great decline of our sheep and wool commenced apparently about fifty years ago. In 1838 we had 384,614 sheep, of which 200,383 were Merinos, 46,985 were Saxonies, and 137,246 other breeds. In 1888, fifty years later, we had 51,539 sheep, of which 4,500 were Merinos, 1,000 were Saxonies, and about 46,000 other breeds. In 1838 the total value of sheep and wool was $1,116,608; in 1888 it was $295,000. Thus it will be seen that in fifty years our sheep have decreased in numbers over 333,000, and our wool 812,000 pounds. While our losses in aggregate numbers have been very large, yet the gain in individual animals shows our great improvement in breeding.

In 1838 each sheep was valued at $1.50, and sheared two and three-fourths pounds to the fleece. Fat lambs were valued at $1.75 each. In 1888 each sheep was worth $5.00, and sheared four and one-half pounds of wool, and lambs were worth $5.00 each. So that men who own sheep now hold a property worth more than ever before.

The following table shows the diminution of the sheep generally, and by breeds, which, with any adequate causes to account for it, I have faithfully pondered over in a spirit of unintelligent curiosity: —

YEARS.	Saxonies.	Merinos.	Other Breeds.	Total.
1845, ...	33,875	165,428	155,640	354,943
1855, ...	6,806	65,584	72,825	145,215
1865, ...	3,126	55,428	110,888	169,442
1875, ...	1,631	14,456	42,686	58,773
1885, ...	1,215	5,307	48,618	55,140

In 1890 the whole number by the assessors' returns was 45,899; the breeds are not given. Since 1865 the decrease has been gradual every year, and almost invariable. What was the cause or what were the causes that produced this unprecedented decline in an industry pleasant and profitable?

DECREASE IN NUMBER OF SHEEP.

Those who know nothing of the subject confidently assert some one reason; those who have studied the matter don't pretend to know, but suppose that all the causes assigned may, combined, have produced the effect for which no one alone can be regarded adequate. Among the causes assigned are the operation and the fluctuation of the tariff; the greatly increased importation of wool from Australia, New Zealand, South America and other foreign countries; the introduction of shoddy (invented in 1803) to a large extent some years later; the enormously increased importation, by enlarged railway facilities, of sheep and lambs from the West; the great increase of the dairy industry in milk, cream and butter; the destruction of sheep by dogs; the diminution of flocks induced by the decay of fences. The first three of these alleged causes for the decrease of our flocks apply especially to loss in the past, while the last four show reasons which act against the revival of this industry. I pass lightly over these, as, in the talk which will follow this paper, these alleged causes will be more fully and satisfactorily considered, and this will form the most valuable part of this meeting.

Importation of Sheep from the West.

One of the most important causes for the decrease of our own home-grown sheep for the slaughter for mutton and lamb has been the great influx of these animals from the West, from Canada and from other States, for killing and not for breeding nor the production of wool, induced by the vastly increased railway facilities showing a large advance in the demand for mutton and lamb in our markets.

At Brighton, on the week before Christmas, 1839, two Franklin County men held four hundred sheep, every one in the market; yet, so ample was that supply and so inactive the demand, that they could not raise the market a half cent a pound, and finally sold with difficulty. Just twenty years after that, Christmas week, 1859, five thousand four hundred sheep changed hands from the drover to the butcher. On the week preceding Christmas, 1889, fifty years from the first date, the receipts were $10,444, and the demand such as called for advanced rates, and a quarter of a cent per pound was easily realized. This increase has continued annually. In 1890 the number of live sheep discharged at Brighton and Watertown was 583,545, of which the Western were 370,067, from Canada 88,313, sheep of Massachusetts 6,181, from Rhode Island and Connecticut 48 head. A very few of these are sold for breeding, some for export, but almost all are slaughtered at the market.

The reports of animals every week (for which I am indebted to Mr. Whitaker of the "New England Farmer") show receipts varying in numbers from 5,000 in March to 17,722 in September and October. This indicates a very enlarged demand for a most nutritious, cheap and wholesome article of food, shown by theoretical considerations, as well as by careful experiment, to be quite equal to beef and superior to pork or almost any of the meats we use.

Dairy Industry.

Probably the great interest at the present time and for some years past in the making of milk, cream, butter and cheese, with a paying price and quick returns for the product, has had much to do in repressing the keeping of sheep and raising lambs, aggravated by the uncertainty of that branch of farm industry through destruction by dogs. The growth of the dairy production has been as remarkable as the decrease of sheep products. As a matter for comparison, I give the dairy products of 1865, the first year that a complete census was attempted for them, with the last, of 1885: —

1865.

Milk,	$1,930,409
Butter,	1,389,027
Cheese,	582,253
	$3,901,689

1885.

Milz, ...	$10,312,762
Butter, including creamery, ...	2,611,351
Cheese, including factory, ...	99,478
Cream, ...	202,706
	$13,226,297

The cows and heifers of 1865 numbered, ...	174,386
The cows and heifers of 1885 numbered, ...	198,997

Fences.

I have no doubt that imperfect fencing had a considerable part in discouraging farmers who were keeping sheep. Many fences, only enough of which are left to make division lines, were built long years ago. The life of a Virginia rail fence is about sixty years; to a stone wall there is no limit of duration, but there is to its ability to turn sheep. A rail fence becomes at last broken and rotten in spots, and must be repaired, sometimes by lopping down a small tree, sometimes by putting in a rotten rail or a couple of insufficient stakes. The stone wall, always a "balance wall," has been rudely laid a hundred years more or less by the unskilled hands of the farmer and his hired man; year after year it has settled, and the top stones have tumbled down, especially on a side hill, aided by long years of storm and by careless hunters and boys. Where the stones have fallen so as to make a set of convenient steps, the sheep will cheerfully walk over, or will crawl through any hole or gap in a fence. Early in the spring the farmer, annoyed at the continual excursions of his sheep the preceding season, starts out with his boys to mend his fences; a long, cold, wearisome job it is, and usually done in the most slouching and perfunctory manner. A few years of this, and he begins to agree with the boys that cows are easier kept.

Recently barbed wire has come to our relief, and a single strand stretched on posts or stakes above the top of the wall makes it pretty secure, while a fence of four or five strands is cheap; will restrain the sheep, and protect them from dogs.

Tariff.

Tariff is a dreadful-sounding word, and causes as much dismay and terror now as it did when borne by that piratical old Arab cut-throat Tarif Ibn malek al-ma-feri, who, taking possession of a small island at the straits of Gibraltar, more than twelve hundred years ago, levied a compulsory tribute from all who came his way sailing in or out of the Mediterranean, and who gave his name to a system of exaction which has continued to this day. What influence this Arab-born institution may have had on the increase or the diminution of sheep and wool of this State, I don't know, and haven't been able to find out by a system of careful reading and inquiry. Twenty-five or thirty years ago it was a common complaint from old farmers who had flocks of hundreds of Merinos and Saxonies that their wool growing was ruined by the tariff, and that they had to abandon sheep raising. My opinion is that, for the past thirty years at least, the effect of any legislation would be very immaterial, considering the small quantity and low grade of our wool, in reducing to any large extent the number of our sheep so terribly depleted; but I leave this to be settled in the discussion to follow.

Dogs and Sheep.

Beyond all question the real reason which deters farmers from engaging in the raising and breeding of sheep at the present time is the constant apprehension of the destruction of flocks and their demoralization by dogs. Our observation and the statements of sheep growers generally throughout the Commonwealth universally show this. We are often asked by dog owners why there is so much complaint now, when there was but little fifty or sixty years ago. The answer is that in numbers the dogs and the sheep are out of all proportion to what they were then. Then, when there were three hundred and forty thousand sheep, with but few dogs, and the sheep in flocks of hundreds, and each sheep worth only a dollar and a half, if a half-dozen sheep were killed they might not be missed, and, if they were, the damage was inconsiderable; but now, when a man has a flock of say forty, each worth six dollars, and often bearing lambs, ravages by dogs, killing a half or a third of his flock, tearing others and demoralizing all, become a very serious matter. I shall not go into any detail of the losses we have had, nor shall I attempt to stir up agitation. It is of no use; dogs and dog owners have the mastery, and a double-barreled shot gun with eleven buckshot, or a few grains of strychnine placed in a beef's head judiciously located as a preventive against loss (*by foxes*), are our only guards. To show how unavailing any attempt at legislation must be, it is enough to give some figures.

The census shows 15,218 dogs, valued by their 13,071 owners at $10.35 each. So much for dog owners and census returns when they make such returns as suit themselves. The county treasurer's books show the tax paid on dogs to be, for 1890, $169,057. The tax is $2.00 per head for males, and $5.00 for females. The number of dogs has not been returned to the comptroller, but, as he says, the number of female dogs being small, you can allow $3,000 for them; dividing the rest of the tax by two gives you 88,000 dogs and about as many dog owners, as against 45,899 sheep and 2,500 owners. It's a pitiable sight: 2,500 men contending for the right to enjoy a peaceable, legitimate and profitable industry, against 88,000 holders of generally dangerous, savage and worthless non-producing brutes.

Sheep as Food.

Mutton and lamb are favorite food of the English and Scotch of all classes; notwithstanding all that has been said or written of the "roast beef of Old England," more mutton is eaten by people of every rank than beef. Mutton formerly was not a favorite food of the people of the United States, though the proportional consumption is greatly increasing; the difference may be largely attributed to circumstances which have led to habit, and habit to a large extent regulates the appetite. The circumstances may be partly these: that formerly we had none of the real mutton sheep to eat; our old native stock was poor, and the Merinos vastly worse. The sheep formerly killed were too often old and poor, and the cheapness of the animals too often brought them as food to those who were compelled to eat them; farm laborers, apprentices, servants and others learned to thoroughly dislike mutton; and many men and women so far advanced as to have perhaps every other recollection of school days wiped from the memory, still retain in the most lively manner the disgust created by the inevitable daily mutton of the boarding-house. The remarkable experiments of Dr. Beaumont, conducted more than fifty years ago, are authority to this day. He found that lamb and mutton were more digestible than any other meats we are in the habit of consuming, were assimilated more readily to the system, and consequently are more nutritious.

While mutton is regarded by medical men and physiologists as the most nutritious meat, it is also the most economical to purchase at the usual prices. English chemists and philosophers, by a series of careful experiments, find that 100 pounds of beef in boiling lose 26½ pounds, in roasting 32 pounds, and in baking 30 pounds, by evaporation and loss of soluble matter, juices, water and fat. Mutton lost by boiling 21 pounds and by roasting 24 pounds; or, in another form of statement, a leg of mutton costing raw 15 cents would cost boiled and prepared for the table 18½ cents per pound. Boiled fresh beef would at the same price cost 19½ cents per pound; sirloin of beef raw, at 16½ cents, costs roasted 24 cents; while a leg of mutton at 15 cents would cost roasted only 22 cents. These facts have been long known and demonstrated, and it is to be much desired that our people should appreciate them and apply them to daily use. The taste for and consumption of mutton will increase according to the quantity and quality of the production. Mr. Mechi, the celebrated farmer and scientist, said he was convinced that beef must sell twenty per cent higher than mutton to make it pay.

In this connection it is pertinent to recall the statement previously made before this Board by one of its most prominent members, of the necessity, in slaughtering sheep and lambs, to remove immediately the paunch and intestines before skinning. If allowed to remain in only a few minutes, they will impart a strong, disagreeable "sheep taste." Probably ignorance and a disregard of this important fact are largely responsible for the disgust in which the flesh of mutton and lamb was formerly held.

The keeping of sheep requires constant care and is full of solicitude, but it is profitable, and, as farming goes among the occupations of men, it is pleasant. This is the commercial and prosaic view; but there is an incident in our history connected with this, poetical and solemn. In this late season of the year, and at the approach to Christmas Day, we cannot dissever the thoughts of this industry from this occasion. It cannot be foreign to our minds, nor is it unworthy of us as Christian men, to remember and note that the first announcement of the birth of the Saviour of the world was made, not to the scientific astrologers who made the heavens their study, not to the learned scribes and Pharisees who pondered the law and the prophets, and not to those who lived in kings' houses clothed in fine raiment; but it was to shepherds who watched their flocks by night on the star-lighted plains of Judea, followed by the sublimest solo and chorus that ever fell on mortal ears, of "Glory to God in the highest, on earth peace and good-will toward men."

The Chairman. Gentlemen, I know I voice your opinion when, as chairman for the day, I thank Mr. Grinnell for his most charming and instructive paper. Mr. Hollis of Boston has kindly come here to give us some figures relative to the amount of mutton that is consumed in Massachusetts. We all know that there is an immense amount of mutton and lamb consumed here which has been imported into this State. We have plenty of land, and all we want is a little ambition among farmers to become shepherds, and we can raise a large percentage, if not all, of the mutton and lamb that is needed in Massachusetts. Will Mr. Hollis kindly give us a few figures?

Mr. Hollis. I arrived in town this morning a few minutes before I came up here, and I am not prepared to give any figures.

The Chairman. In a general way can you not say about how many carcasses you slaughter or your company slaughters?

Mr. Hollis. Well, I happen to have in my pocket a little paper on which I have kept a memorandum of the number of sheep we have slaughtered since 1885. In 1885 we slaughtered 376,415; in 1886, 367,822; in 1887, 399,272; in 1888, 387,345; in 1889, 396,124; in 1890, 414,620. In the ten months of this year, up to the first of November, we slaughtered 357,484.

The CHAIRMAN. Thank you very much. That shows, gentlemen, that the demand for mutton is not on the decrease. Will Mr. Hollis kindly tell us about what price mutton has averaged for the last eight or ten months?

Mr. HOLLIS. I do not think that I could. It varies from month to month.

The CHAIRMAN. But for good fair mutton you usually get from 5 to 6 cents a pound for the carcass dressed, do you not?

Mr. HOLLIS. I think it will vary from 6 to 10 cents a pound, and lambs from 6 to 12½ cents.

Mr. GRINNELL. What proportion of the carcasses are exported from Boston?

Mr. HOLLIS. There has not been any exported for the last two or three years. I do not think there is any mutton exported from the United States now.

Mr. GRINNELL. Then of course all the sheep that come into the Brighton and Watertown markets are slaughtered there?

Mr. HOLLIS. Yes, sir.

Mr. GRINNELL. Is there any reason for the variation in the amounts in one year and another?

Mr. HOLLIS. That is owing to the supply and demand. There is no particular reason for it, that I know of.

Governor HOARD. I would like to ask the gentleman from what territory those sheep are mostly obtained?

Mr. HOLLIS. You might say from Halifax down to Virginia. From the first of June until the first of September we get our supply from Kentucky, Tennessee and Virginia.

Governor HOARD. Have you noticed any particular improvement in the mutton character of the sheep you have received during this year?

Mr. HOLLIS. From some sections there is, others not.

Governor HOARD. From what sections do you find an improvement?

Mr. HOLLIS. From some parts of the West and some sections in Canada.

Governor HOARD. I mean, of course, in the eating quality.

Mr. HOLLIS. Yes, sir; we see quite an improvement in the sheep coming from Virginia and Tennessee.

Governor HOARD. Do you attribute it to improved breeding?

Mr. HOLLIS. Yes, sir.

The CHAIRMAN. Well, gentlemen, we have learned that there is a demand for mutton, and we want to learn how to raise it, and we want to know how to keep out troublesome and dangerous intruders. Mr. SESSIONS, I think, is prepared to talk a little about fencing.

Secretary SESSIONS. Mr. Chairman, I am of the opinion that the proposition advanced by the lecturer that the fence question has had considerable influence in the decadence of sheep keeping in Massachusetts is correct. As I go among farmers and talk about the sheep industry they reply to me, "We cannot keep them anywhere; it will cost so much to fence them in or fence them out that it is a nuisance; and without fences we do not know where we shall find them in the morning or in the evening." Now, this is a serious problem, as the lecturer has pointed out. The fences in the more rural and farming districts of the State are of the character which he has noted, — the old Virginia rail fence and stone wall; and every one who has had experience with sheep knows that a stone wall is of very little use, unless it is a very expensive wall, built perpendicular on the side towards the sheep. And then, again, the old Virginia fence that was a good fence when it was first built, becomes old and dilapidated and costs a great deal for repairs; and when you have got to refence a pasture or make repairs to any great extent, the cost will be enough to deter a beginner from undertaking to raise sheep.

Now, the essayist also alluded to a new material for fencing, — barbed wire. There is in the minds of some people, many people, perhaps, a prejudice against barbed wire, because of its liability to injure any animal; but my own experience teaches me that that objection does not apply to sheep. I have fenced sheep for years with barbed wire, and I never knew a sheep to be injured by it. Occasionally a sheep will be caught by it, and perhaps a trifle of wool will be pulled off, but the waste and suffering that comes to the sheep from that cause is trifling.

Now, of course the question of fencing in sheep with any kind of fence depends upon its cost and its adaptability to the end in view; and with us I think the question of cost is really the one to be considered, for it is perfectly patent to every man that barbed-wire fence can be so constructed as to turn sheep. There is another point about this barbed-wire fence which does not apply to a fence of any other material, and that is, that it can be made so as to turn dogs. I think it is perfectly feasible to construct a fence that will turn dogs; and the cheapness of the material as now furnished by the manufacturer is such that the cost of a fence that will not only turn sheep but protect them from dogs is comparatively small. I have some figures which I have collated from information obtained from different parties; and, having applied to them my own experience, observation and judgment, I believe the estimates are reliable considering the circumstances under which they are made. Of course, in making an estimate of the possible or the probable cost of a certain kind of fence, the estimate must be made upon some definite set of circumstances; and it is only safe to predicate upon the most favorable circumstances, because the amount of obstacles to be overcome will vary in different circumstances and under the different conditions of different farmers, and that must be calculated by the individual himself, he only knowing what the obstacles are. I refer to the cost of digging post-holes, the cost of overcoming the difficulty of uneven ground, getting through bushes, and all that sort of thing. These figures were based largely upon a statement of the cost of eighty rods of six-wire fence built about two years ago by Mr. Henry Green of Hadley, Mass. He says there has not been a single dog in the pasture since the fence was finished. The four lower wires are placed nearer together than the two upper ones. The fence is four feet high and the posts one rod apart, which is sufficient to support a barbed-wire fence. The wire cost 4 cents per rod; the staples 1 cent per rod; the posts cost 7 cents each. Mr. Green says that two men can set the posts and string the wire for twenty-five rods in a day. The cost of labor per day is say $1.50 per man, or at the rate of 12 cents per rod. So we have as the cost per rod: six strands of barbed wire, at 4 cents, 24 cents; staples, 1 cent; one post, 7 cents; labor setting posts and stringing wire, 12 cents. Total, 44 cents. This, remember, is a dog-proof as well as a sheep-proof fence.

I have also received, at my request, a price-list from the Washburn & Moen Manufacturing Company, Worcester, which gives the cost of first-quality galvanized Glidden barbed wire at 4 cents per pound, and they state that it weighs one pound per rod, and their discount for cash will cover the freight. So that Mr. Green's estimate of 4 cents per rod is borne out by the price-list of the largest manufacturing establishment of the kind in the State.

I have also a statement from Prof. W. P. Brooks of the Massachusetts Agricultural College that one man set the posts (one rod apart) and strung the wire for sixty rods of five-strand wire fence on the college farm in less than two days. This proves that the labor estimate in the first instance is a fair one.

These statements correspond with my own experience. They are for work done where the soil is not stony or underlaid with hard-pan. Allowance must of course be made for such obstacles.

From the foregoing I calculate that it will cost to fence a square lot of ten acres (one hundred and sixty rods) with six wires and posts $70.40, or, per acre, $7.04. I am satisfied that five wires can be so arranged as to be a dog-proof fence as well as a sheep-proof fence; and therefore I have made a calculation of the cost of a five-wire fence, which amounts to $62.40 for a square lot of ten acres, or $6.24 per acre. As you all know, the larger the field the less the distance around it. I have on that account made calculations for several sizes. To fence a square lot of twenty acres (two hundred and twenty-six rods), six wires, with posts, $99.44, or a cost per acre of $4.97; with five wires and posts, $88.14, or a cost per acre of $4.41.

But there is another set of conditions on many of our pastures, especially upon the hills in the western part of the State and upon the pine plains of that section, where the pastures have been neglected and considerable timber has started, and where a line of trees will be found along the line of the proposed fence, so that in many instances posts can be dispensed with by stringing the wire on trees. Of course the trees would not be at regular distances in all cases; but by having posts every six, eight, or even ten rods, the intervening supports can be made of stakes which can be driven, with the help of a bar to make the holes, at a comparatively trifling cost, and the material can be gotten from the trees as you go along. I have therefore made a calculation here, leaving out the posts and the cost of setting the posts, so that persons having pastures situated in the way I have described may reduce the necessary cost of fencing very considerably. My calculations are as follows: —

To fence a square lot of 20 acres, six wires (226 rods), posts,	$99.44
Cost per acre,	4.97
With five wires and posts,	88.14
Cost per acre,	4.41
To fence a square lot of 20 acres, six wires, where trees take the place of posts, discounting cost of posts and one-half cost of labor,	70.06
Cost per acre,	3.50
With five wires on trees,	58.76
With five wires on trees, per acre,	2.94
To fence a square lot of 30 acres (277 rods), posts, six wires,	$121.88
To fence a square lot of 30 acres (277 rods), posts, five wires,	108.03
Cost per acre, six wires,	4.06
Cost per acre, five wires,	3.93
To fence a square lot of 30 acres, without posts (trees), six wires,	85.87
To fence a square lot of 30 acres, without posts (trees), five wires,	72.02
Cost per acre, six wires,	2.86
Cost per acre, five wires,	2.40
To fence a square lot of 50 acres (358 rods), posts, six wires,	$157.52
To fence a square lot of 50 acres (358 rods), posts, five wires,	139.62
Cost per acre, six wires,	3.15
Cost per acre, five wires,	2.79
To fence a square lot of 50 acres, without posts (trees), six wires,	110.98
To fence a square lot of 50 acres, without posts (trees), five wires,	93.08
Cost per acre, six wires,	2.22
Cost per acre, five wires,	1.86
To fence a square lot of 75 acres (437 rods), posts, six wires,	$192.28
To fence a square lot of 75 acres (437 rods), posts, five wires,	170.43

Cost per acre, six wires,	$2.56
Cost per acre, five wires,	2.27
To fence a square lot of 75 acres, without posts (trees), six wires,	135.47
To fence a square lot of 75 acres, without posts (trees), five wires,	113.62
Cost per acre, six wires,	1.81
Cost per acre, five wires,	1.51

To fence a square lot of 100 acres (503 rods), posts, six wires,	$221.32
To fence a square lot of 100 acres (503 rods), posts, five wires,	196.17
Cost per acre, six wires,	2.21
Cost per acre, five wires,	1.96
To fence a square lot of 100 acres, without posts (trees), six wires,	155.93
To fence a square lot of 100 acres, without posts (trees), five wires,	130.78
Cost per acre, six wires,	1.55
Cost per acre, five wires,	1.31

To fence a square lot of 200 acres (716 rods), posts, six wires,	$315.04
To fence a square lot of 200 acres (716 rods), posts, five wires,	279.24
Cost per acre, six wires,	1.57
Cost per acre, five wires,	1.39
To fence a square lot of 200 acres, without posts (trees), six wires,	221.96
To fence a square lot of 200 acres, without posts (trees), five wires,	186.16
Cost per acre, six wires,	1.11
Cost per acre, five wires,	.93

To fence a square lot of 500 acres (1,131 rods), posts, six wires,	$497.64
To fence a square lot of 500 acres (1,131 rods), posts, five wires,	441.09
Cost per acre, six wires,	.99
Cost per acre, five wires,	.88
To fence a square lot of 500 acres, without posts (trees), six wires,	350.61
To fence a square lot of 500 acres, without posts (trees), five wires,	294.06
Cost per acre, six wires,	.70
Cost per acre, five wires,	.59

To fence a square lot of 1,000 acres (1,600 rods), posts, six wires,	$704.00
To fence a square lot of 1,000 acres (1,600 rods), posts, five wires,	624.00
Cost per acre, six wires,	.70
Cost per acre, five wires,	.62
To fence a square lot of 1,000 acres, without posts (trees), six wires,	496.00

To fence a square lot of 1,000 acres, without posts (trees) five wires,	$416.00
Cost per acre, six wires,	.49
Cost per acre, five wires,	.41

So you see it does not take a fortune to fence a large lot. And this, remember, is a dog-proof fence as well as a sheep-proof fence.

The Chairman. Well, gentlemen, we have not only found that we can afford to raise sheep in Massachusetts, but we have found out by actual figures that it is cheaper to build a dog-proof fence than it is to lay up a stone wall.

Mr. Grinnell. Does anybody know the cost of a board fence built of boards say six inches wide, four on a post?

The Chairman. Mr. Horton, will you kindly tell us the expense of a board fence?

Mr. Horton. It is very easy to get at the expense of such a fence as that. The boards for a four-board fence with us cost on an average about $16 per thousand feet, which would be $1.60 for a hundred feet of fence. It takes double the number of posts that it does for a wire fence, and the posts require to be better posts than for a wire fence. Under ordinary circumstances a board and post fence four feet high would cost something over a dollar a rod, — from $1.06 to $1.10, using good material. Figuring it upon that basis, it would cost about three times what it would to make a wire fence.

The Chairman. And, instead of keeping dogs out, it invites them to jump through. Gentlemen, we want to cover the ground of sheep husbandry as carefully as we can, and I will call on Mr. J. D. Avery of Buckland, who has been a practical and successful shepherd for a good many years.

J. D. Avery. Mr. Chairman, some few weeks ago I received a line from the essayist suggesting that I make a comparison between dairying and sheep growing. I attempted to do this, but have not succeeded, for the reason that the dairymen were not prepared to give me figures showing their receipts and expenses. I have figures from three sheep farmers, showing their receipts, and in one instance the writer gives me his expenses, and it may be interesting to you to hear those figures read.

The first flock to which I will call your attention consisted of 21 breeding ewes in the year 1890. They were fed upon rowen hay twice a day during the winter till the first of March; after that they were fed oftener, and a daily ration of grain was added, consisting of bran four quarts, oats four quarts, and corn two quarts. They were turned to pasture May 1. The receipts that year were as follows: —

28 lambs, average weight August 1, 91 pounds. sold at 6½ cents per pound,	$165.62
168 pounds wool, at 22 cents,	36.96
Total,	$202.58

which is very nearly $10 per head. This gentleman gave me no figures of the expense except the grain, which amounted to only $9 for the 21 sheep.

Question. Where were those sheep kept?

Mr. Avery. This flock was in the town of Shelburne.

Question. What was the breed of sheep?

Mr. Avery. A high-grade South Down. I have known this gentleman's flock for the last ten or fifteen years, and he has used nothing but the very best of pure-bred South Down sires. He has paid on an average probably $25 for those rams, used them two years, then changed them to prevent in-breeding, and he has replenished his flock by keeping the best of the lambs. I figure those lambs as all sold at 6½ cents per pound; he did not sell them all, but of course it is perfectly fair to figure them at that price. He reserved five of the best of the lambs, which averaged 100 pounds apiece.

Question. At what age?

Mr. Avery. They were dropped in March, and they were sold the first of August. Something like five months, perhaps. He has improved his flock in that way, by using the best pure-bred sires and selecting the best of the lambs. Now, these lambs would have brought him 6½ cents a pound per head if he had sold them, and most of us would probably have thought that was too much of a temptation to resist, and would have let them go to the butcher; but, if we are going to get a flock of sheep which will give us the result which this flock gave him, I do not know of any way that we can get them except to raise them in this way. I have made an estimate of the expense. The grain as he has given it to me would amount to about $9; hay, estimated at 6⅓ tons, at $10 per ton, $63; pasturing 21 sheep 28 weeks, at 5 cents each per week (which I think is a very liberal estimate), $29.40; service of ram, $5.25; making a total of $106.65, which leaves a balance of receipts above expenses of $95.93.

QUESTION. He got about $1.75 each for the wool?

Mr. AVERY. Yes, sir; just about that.

The CHAIRMAN. That proves just what I have been trying to impress upon the farmers of Massachusetts for the last eight or ten years, with very poor success; that is, that any farmer who has a good flock of sheep and who knows how to treat them as Mr. Avery and the gentleman who has given the statement which has been read here do, with average good luck, may reasonably expect to get an income of twenty-five per cent of the investment.

QUESTION. Is that a continuous income from the sheep, — an income that comes every day?

The CHAIRMAN. It does not come every day.

Mr. AVERY. It comes perhaps twice a year. I have a statement from another gentleman who raises what we term early lambs, or spring lambs, which are turned to market without ever being turned to grass. In this case the lambs were dropped in December and carried to market in March and April. Flock No. 2 numbered in 1890 17 breeding ewes. The receipts from these 17 ewes were as follows: —

150 pounds wool, at 23 cents,	$34.50
16 lambs, at $9.06¼,	145.00
3 lambs, at $5,	15.00
Total,	$194.05

I presume those three lambs which he kept came later, and were reserved to replenish his stock. I made an estimate of the expense of this flock also, as follows: —

5$\frac{1}{10}$ tons of hay, at $10 per ton,	$51.00
Grain for sheep,	25.50
Grain for lambs,	16.00
Pasturing 17 sheep 28 weeks, at 3 cents each,	14.28
Service of ram,	4.25
Total,	$111.03

Balance of receipts above expenses, $83.47.

In this case there were no lambs to be pastured, and the ewes could be pastured for about one-half the cost of those that have lambs, as lambs must have the best of pasture. This flock of sheep was produced by crossing a Spanish Merino ram upon grade Cotswold and Leicester ewes, and those ewes will weigh from 125 to 150 pounds. They drop their lambs very early, most of them in December; and they are ready for market early, and bring a better price than those which are dropped later.

Mr. Ware. It will be noticed, probably, that there has been no credit given for the manure during this time, which is a fair item of credit.

Mr. Avery. I have offset the manure against the labor, which is a very liberal allowance for the labor. I should be very glad to take a thousand sheep and take care of them for one-half the manure, if any one would furnish the hay and grain.

The Chairman. You mean to be liberal in your estimates?

Mr. Avery. Yes, sir; I mean to be.

Question. I would like to ask Mr. Avery, if he increased his flock four or five fold, if he would get the same result as from a smaller flock?

Mr. Avery. Probably not. Sheep will do better in small flocks. I do not think the result would be as good with a large flock. I think it is usually considered in that light.

Flock No. 3 consisted of 53 ewes, 6 lambs and 1 ram, making 60 in all. The expenses were as follows:—

Grain for sheep and lambs,	$104.50
Hay, estimated at $2 per head,	120.00
Pasturing 60 sheep 28 weeks, at 3 cents,	50.40
Service of ram,	13.25
Total,	$288.15

The owner of this flock gave me an estimate of the expenses. He said the grain which he fed to his sheep was kept separate, so that he knew just what his grain cost him which he fed to his sheep and lambs, and it amounted to the sum I have given. I will say that he also raises what we term early lambs. His receipts for lambs and wool sold amounted to $629.50. He did not divide this up for me. I had asked him in previous years what he was getting for his lambs, but he never seemed inclined to tell me, and he has not here. He gave, as the total receipts for lambs and wool, $629.50, which you will see is almost $10.50 per head. Balance of receipts above expenses, $341.35.

These sheep are the Vermont Merino. They are a very superior flock of sheep for that breed. They will weigh probably 100 or 110 pounds each, and probably shear from eight to ten pounds of wool each. They drop their lambs in November and December. I saw the gentleman two weeks ago, and he had nine lambs at that time, and more coming right along. He has the advantage of the rest of us in marketing his lambs, or has taken the advantage, by selling his lambs dressed directly to the hotels in this city. He has a son here who has assisted in finding him a market, and I presume he gets one or two dollars a head more than the rest of us. I think he must.

Governor HOARD. Is the sire a Merino also?

Mr. AVERY. No, sir. In all the cases of which I have spoken, the sire is a pure-bred South Down.

The CHAIRMAN. Mr. Avery, won't you give us an account of your own flock, which is probably one of the best in the State?

Mr. AVERY. No, sir; I cannot show as good figures as these men.

The CHAIRMAN. These are all too good. You know people will not believe some of these stories.

Mr. AVERY. Well, I have not prepared any figures from my own flock.

Secretary SESSIONS. How many do you keep?

Mr. AVERY. I keep from 100 to 300.

Secretary SESSIONS. Your experience as far as you could give it would be very interesting, because your flock is a large one compared with those which you have mentioned.

Mr. AVERY. I can tell you about what I get for my lambs, and about what I think it costs to raise them. The best that I have ever done in any year was some five or six years ago, when I raised 200 lambs from 180 ewes, and sold those lambs for $1,600, and my wool averaged me about $1.50 per head. But I estimate the expense of keeping sheep higher than most farmers do. I have never weighed and kept an accurate account of the grain, but I think it costs me about $3 per head for grain for the ewes and lambs, which is more than a dollar a head higher than this gentleman estimates of whom I have last spoken; but he says he does not know what the exact cost was. Perhaps he did not feed as much grain as I do.

The CHAIRMAN. Do you feed grain in summer?

Mr. AVERY. No, sir.

Mr. GRINNELL. When does he turn his lambs? That makes a difference.

Mr. AVERY. His lambs are dropped in November and December, nearly all of them, perhaps some as late as January; and they are marketed in March and April mostly, some perhaps as late as May.

Hon. JOHN E. RUSSELL. Do you keep 300 sheep in one flock?

Mr. AVERY. No, sir; I do not. In the winter my flock is divided up into pens of perhaps 25, although perhaps 75 or 100 will be connected, with just a board fence, you might say, between them. The hay I estimate at $3 per head and the grain at $3 per head for sheep which raise early lambs. I know that is a higher estimate than most farmers make, and perhaps it is too high. I have thought sometimes that I would experiment in that direction, and weigh my hay and keep an accurate account of the grain; but it would be quite an undertaking, especially to keep an account of the grain, where there is a mixed stock and the stock are all fed from one bin.

Secretary SESSIONS. What is your estimate for pasturage?

Mr. AVERY. I have figured the cost at 3 cents per week for 27 or 28 weeks, but it does not actually cost me that. I hire pastures, and in that way I get them pastured for perhaps 2 cents a week sometimes.

Secretary SESSIONS. What is your pasture?

Mr. AVERY. It is an old pasture, hilly and rough.

QUESTION. Do you take any precautions against dogs?

Mr. Avery. No, sir; I have not taken any precautions against dogs, and never have had any serious trouble. In some sections of our county some very valuable flocks have been entirely ruined by dogs. I have fortunately escaped anything of that sort.

There is one point to which the essayist alluded which I wish to emphasize, and that is, that the keeping of sheep requires constant care and attention. I think there is where many of us fail. We think that we can slight the sheep; that they can get along almost any way, and shirk for themselves. That is not so. They require a certain amount of care. They do not require anywhere near as much care as a herd of cows, the labor is not nearly so much; but they should have just as good care as you give your cows. If you neglect your dairy cows for a day or two, the milk pail will tell the story; but it is not so with sheep; none but a practised eye will notice the difference. But, if you are raising early lambs especially, those lambs will very soon show any neglect, and if they are neglected for a short time they never will recover from it. There is no way to get along with them and raise them successfully but to give them good care and attention and good feed, and fit them for market as soon as possible. The sooner and the younger they can be prepared for market, the greater will be the profit. It costs less to fit lambs for market if you do it in eight or ten weeks than it does to be twelve or fourteen about it.

A. J. Bucklin (of Adams). What is your method of housing in the winter? How large an extent of shed room do you require?

Mr. Avery. My sheep sheds are old-fashioned, as you might say. The sheds were built before I went on the farm, probably thirty or forty years ago, and they are not remarkably warm; but still, by fixing them up a little I make them warm enough, — as warm as I care to have them. I hardly ever lose a lamb in cold weather on account of getting chilled. As to the amount of space which they require, I have in one pen now, which is 26 feet square, 50 ewes, and I think that is perhaps as close as they should be; perhaps more room would be better for them, but still they will do very well with that amount of room. After they drop their lambs and the lambs begin to eat, it will be necessary to give them more room.

Governor HOARD. I would like to ask the gentleman how many mutton sheep can be kept safely in one flock?

Mr. AVERY. Do you mean in the pasture, or in the barn?

Governor HOARD. In the pasture first.

Mr. AVERY. Well, the largest number I have kept as a rule is 75 or 80.

Governor HOARD. How many in winter quarters?

Mr. AVERY. The largest number which I have in one pen at the present time is 50. I do not know but they might be kept in larger numbers safely, but I do not think it is as well. If they are kept in small flocks it prevents their crowding.

The CHAIRMAN. If Mr. Avery will allow me, I have kept as many as 500 in one flock without any detriment, where there was plenty to eat in the pasture. In winter I should always divide them up into flocks of 30 or 40, although I am at present keeping 175 in one flock, and they do very well. You have got to use lots of common sense with sheep, besides care.

Governor HOARD. Have you had any experience in feeding ensilage to sheep?

Mr. AVERY. I have not.

Mr. HAVEN. What breed are your sheep?

Mr. AVERY. My sheep are grade South Downs.

Mr. HAVEN. Have you tried other breeds?

Mr. AVERY. I have tried the Merino, and had very fair success with them.

Governor HOARD. In Wisconsin we have had quite disastrous results in feeding sheep when with lamb too heavily with ensilage. It being a carbonaceous food, it did not seem to give the proper growth. Can you house mutton sheep closely with safety? And, in connection with that matter of housing, I want to know whether you can secure thorough ventilation in your houses in winter?

Mr. AVERY. Well, if they are housed closely, it is very necessary and important that the pens should be ventilated in some way. There are very few days in the winter when some of the windows of my sheep pen are not open.

Governor Hoard. Do you keep them constantly bedded, so that they shall not lie in filth?

Mr. Avery. I do, most certainly.

Governor Hoard. What do you use for bedding?

Mr. Avery. I use brakes, as a rule, which I mow in the pastures.

Governor Hoard. How would you handle and feed a ewe when she lambs in December, for instance, and you want to prepare that lamb for early spring mutton?

Mr. Avery. I should feed her well from the time she went to the barn. I should want her to go into winter quarters in good condition; and, if I had plenty of fine early-cut hay and rowen, that would be all I would care for until after lambing. Soon after the lamb was dropped I should commence to feed a little grain, and the amount of grain would depend upon the quality of the hay. I have fed as high as a quart, — I have fed higher than that. I once fed a few ewes which had two lambs each, — I was fattening the ewes as well as the lambs for market, — I fed them over two quarts per day.

Governor Hoard. What kind of grain?

Mr. Avery. It was linseed meal, cotton-seed meal and provender, — corn and oats ground together and mixed in equal parts. It was more grain, I suppose, than most people would feed to sheep; but it should be borne in mind that those were large ewes, and suckling two lambs each.

Question. Do you feed roots at all?

Mr. Avery. No, sir; I do not, although I think they are very excellent food for sheep.

Governor Hoard. Do you feed any peas?

Mr. Avery. No, sir; I do not. I have had no experience in growing peas.

Governor Hoard. Has any gentleman in the room had any experience in that direction? Several gentlemen in the West have been experimenting with peas for the past two years, with very remarkable success, both in dairy work and in sheep work, and we have learned some things that we did not know two, three or four years ago even. In planting field peas plough the ground in the fall, selecting not too rich soil. In the spring, as early as possible, paying no attention to early frosts, drag the ground thoroughly, sow the peas, and plough them under about four inches deep. After the peas are ploughed under, sow on the top from three pecks to a bushel of oats to an acre, to assist in holding up the peas. Cut the crop when ready with an ordinary mower or reaper. We find that we can get from an acre of peas the equivalent in value of 4,500 pounds of bran.

Mr. GRINNELL. I want to say that some two or three weeks ago I prepared some circulars containing about a dozen questions, and sent them around to various gentlemen represented to me as being sheep raisers. I sent them out by the hundred. I have received over sixty replies to those circulars. They contain a great deal of very interesting matter, which, if tabulated, would embrace all that has been said to you in regard to the keeping of sheep, — the cost, the profit, and so on.

The CHAIRMAN. Well, gentlemen, we are gathering a good deal of information about the raising of sheep; but there is one thing which we want to learn a little something about, and that is about our old Arab friend. We have an old friend of the Board here who knows more or less about the tariff. I should like to hear from the Hon. JOHN E. RUSSELL.

Hon. JOHN E. RUSSELL (of Leicester). Mr. Chairman, Members of the Board, and Gentlemen: It is eleven years last August since I was elected Secretary of the Board of Agriculture, and during that year I said several times in public, that if at the end of five years I had not increased the sheep in the Commonwealth of Massachusetts by my advocacy of sheep husbandry to the number of half a million, I should feel that I had been secretary in vain. After six or seven years I retired from the office, and there were about half or two-thirds as many sheep in the Commonwealth as when I began to advocate sheep husbandry. Otherwise perhaps I was of service to the Commonwealth in my position; I flatter myself that I was, but I did not increase the interest of the farmers of the State of Massachusetts in sheep husbandry. We had very animated meetings and institutes all over the Commonwealth, but I notice that there has been one very great step of progress taken. This is the first public meeting that I have ever attended in which this question was discussed, that the whole matter was not met at the outset by the cry, "We cannot keep sheep on account of dogs." We have not heard that here to-day, and I take it that the farmers of Massachusetts have got to the point where they consider that they can keep sheep if they choose to do so, dogs or no dogs. They have also made up their minds that they cannot prevail any further with the Legislature of Massachusetts than we went during my term as secretary, when we had the law very largely amended in our favor; and we now have as favorable a law on our side in this Commonwealth as we can expect to have, or, I may say, as we are entitled to have.

I am glad to talk upon the sheep question; but I do not propose to discuss our old Arab friend particularly, because I do not recognize that the tariff upon wool has much to do with the sheep husbandry of Massachusetts. We do not raise wool enough to make it at all important to us what the tariff is. I once said, amid the jeers of a good many men who ought to have known better, that the farmers in the States west of the Mississippi River, — I stated it on the floor of the House of Representatives, and it is in the congressional record, — that the farmers west of the Mississippi River could afford to keep sheep if wool was worth no more than hen feathers. Having said that there, I can say here that it is immaterial what the tariff is. I might add to that, as a sort of snapper, that when wool was free in 1859 it was worth more money in all parts of the United States, considering the value of money at that time, than it had ever been before, and worth more money than it has been since 1867 under a high tariff. The secretary says, "or ever will be in the future." That may be, too. I am glad to get a good price for my wool, of course; but I do not reckon the wool as an absolute necessity of my sheep keeping. I should keep my sheep first for lambs, second for mutton, next for the improvement of my pastures and the manure that I could get out of the sheds; then if I get $125 or $150 for my wool, that is so much addition to my profits. I agree with the gentlemen who have spoken here who have kept sheep, as I have, for some years, that there is a constant annual profit; not a daily profit, as one gentleman here wanted to get, although I have known cases where sheep raisers got a daily profit by marketing the ewes' milk; but I do not think we need to do that in Massachusetts to make a profit. But the annual profit of the sheep is, we might almost say, an absolute certainty. I told a poor farmer within two or three months, that, if he had my flock, which has never exceeded 75 or 80, he could support his family, pay his taxes and hold a respectable position as a farmer with nothing more than that flock, a garden, and what he could do on 25 acres of land.

Mr. SHAW. I want to ask if your sheep in the winter have exercise, or are they kept in a pen all the time?

The CHAIRMAN. I have found from experience that with sheds as close as I have, allowing about 10 square feet to a sheep, and dividing them up into flocks of 50 or 60, they need a small yard for exercise. The larger the yard we can have, and keep it dry, the better.

QUESTION. Has anybody ever tried soiling sheep as we soil cattle?

The CHAIRMAN. I do not know whether any other gentleman has done that or not. I have tried it in a very small flock myself.

Governor HOARD. That is the English practice. All the flocks of England are soiled. That is, they have a small run of pasture, and generally a movable fence is used. They plant green crops and let the sheep feed on them, moving their hurdles four feet in the morning and at noon, and eight feet at night, and thus make the sheep eat everything perfectly clean. In that way they feed on the green crop and manure the field as they go along, and then the land is ploughed over and sowed with another crop.

The CHAIRMAN. I am not aware that that has been tried in this country, except in an experimental way. I think it has been tried at Amherst with English rape.

Governor HOARD. There are some surprising results given by Professor Shaw at Ontario College. We have commenced to try it in Wisconsin, so far with very flattering results. Professor Shaw makes the bold statement that there will be within a comparatively few years ten million sheep fattened in this country on rape, and he gives figures, which unfortunately I have not with me, which show very surprising results from the sheep fed on rape; and the growth that he made upon lambs and sheep from New Brunswick and the eastern Province of Ontario almost passes belief; but the figures are given with the assurance that they are absolutely correct.

The CHAIRMAN. Will Colonel Needham kindly give us some account of his dealings with sheep in former years? I think he took a celebrated flock across the water.

Hon. DANIEL NEEDHAM (of Groton). I will occupy a brief moment. This is a subject which has always been of great interest to me. I had something of a flock of sheep in Vermont for quite a number of years. I had the old Consul Jarvis sheep, which he sent to this country as early as 1810 or 1811. The bucks were sold in New York at that time for about $1,000 apiece; the ewes brought from $100 to $150 and $200. The sheep which I took to Europe, to which Mr. Grinnell alluded in his address this morning, were the Spanish Merino; that is, they were the descendants of the sheep which were imported by Consul Jarvis. Mr. George Campbell of Vermont had travelled with American breeders throughout Europe on two different occasions previous to 1863, when those sheep were exhibited at the Hamburg International Exhibition; and he was satisfied that it did not belong to Germany that she should have the exclusive right to claim the production of blooded Merino sheep; that as good sheep could be found in the United States as could be found there; and he was confident that he had as good sheep on his farm as he saw in Spain, in Saxony or Germany. In 1863, as very likely many of you may remember, I was appointed a commissioner from Vermont to go to the International Exhibition at Hamburg, to which the United States was invited to send sheep. The great interest of Vermont in that exhibition was in connection with the breeding of sheep, and George Campbell was the only man in Vermont or in the United States who dared to venture on the sending of Merino sheep to that exhibition. He sent twelve, and I went over in the same ship that carried the sheep and the shepherd, and in which Mr. Campbell was also a passenger. I remember that there was a German baron on board the ship, who went to Mr. Campbell and said, "I understand you have some Merino sheep that you are going to take to Germany to compete with German Merinos?" Mr. Campbell said "Yes;" and he said, "Well, it is the old story of carrying coals to Newcastle," — and we almost felt that it was so. The sheep reached Hamburg all right, though they had been a little seasick on the passage, but they had eaten reasonably well. They had been well fed with oats and beans. We always fed our sheep with beans in Vermont, as one of the best means of producing a good heavy fleece of wool. Those sheep were made the subject of very general discussion in the newspapers. Mr. Charles L. Flint, who was the predecessor of Mr. Russell, in the office of secretary of the Board of Agriculture, was also a commissioner to that exhibition for the State of Massachusetts. Governor Wright of Indiana was the commissioner from his State and from the United States, appointed by President Lincoln; and Rhode Island and other States had commissioners there. When our sheep got there they immediately began to be the butt of ridicule of the German press, and they took up the story of the baron, that it was "carrying coals to Newcastle;" that the United States — they did not know anything about Vermont — had sent sheep over to Europe to compete with the Spanish Merinos of Germany. Germany had had almost full sway in the production of stock Merino sheep for more than thirty-five years, — ever since Spain gave it up. We nevertheless went to work, put our sheep into pens, and entered them in the various classes. There were some three hundred Merinos at the exhibition. The judges of the exhibition were men who knew nothing about the owners of the sheep, except so far as they were obliged to know. They were obliged to know that there was only one lot of sheep sent over from the United States, and so far as they had to know they knew of the owner; but when those sheep passed under the inspection and study of the judges it seemed to me that they were unprejudiced. They were called "Vermont Merinos," but I venture to say that there were not fifty men on those grounds, which sometimes contained one hundred thousand people, who knew where Vermont was. They had an idea that it was somewhere over here in this western hemisphere, but where they did not know. The judges went around and made their decisions, and when they came to compare notes they gave those Vermont Merinos two first premiums and one second premium. The excitement on the ground was intense. No language that I can command could depict the excitement among the German and French breeders. Louis Napoleon himself, then the Emperor of France, had on exhibition right by the side of those Vermont pens, in a highly decorated pen built by himself, sheep competing with those Vermont sheep; and there were distinguished breeders from various countries of Europe, and some from South America. The decision was, of course, very acceptable to the American commissioners. Governor Wright came to me and said: "A great victory has been won for our country; it will result in a change of the current of trade in stock Merinos. Our people have heretofore sent to Germany for their stock sheep, but now they will send to Vermont, — the American people will find their stock sheep at home." And they did.

But I must tell you a little more about this excitement. The German and French breeders did not believe that the decision could be honest; and yet the men who constituted the judges were largely Europeans; they were of all nationalities. The excitement, as I said, was very great, and Governor Wright said to me, "I don't know but they will mob you and Mr. Campbell," so wrought up were the breeders who were exhibiting on the grounds. They did not believe that anything good could come out of America. I made up my mind that there was one test which could be applied. These sheep were not sheared. One of the first prizes which was awarded to us was upon the weight of fleece in comparison with the weight of body. That could be tested, and I offered 100 thalers, which is $70, for the sheep that would shear the heaviest fleece for the weight of body in the class of Merinos, the sheep to be sheared and the fleece to be weighed in the presence of a new jury appointed by the German league and in the presence of the whole public. I had that notice printed in French, in German and in English, and put up on every pen on the great exhibition grounds, and three days were given for the entries. When the third day had expired no entries had been made except by George Campbell of the United States of America. Then the German press turned round and said, "The American gentlemen have vindicated their integrity, and the exhibitors and breeders of the European sheep on exhibition here have not dared to enter." After the exhibition Mr. Campbell came home, and Governor Smith of Vermont in his next message said that the result had been worth a hundred thousand dollars to the State of Vermont; and he told me afterwards that he might just as well have put in his message that it was worth a million of dollars to the State of Vermont. Vermont sent sheep to Australia, to Texas and all over the United States, where the leading breeders had been in the habit of sending to Germany; and the whole trade in stock Merinos was changed from that great entrepot of Spanish Merinos, Germany, to the United States.

Secretary SESSIONS. I do not believe that this discussion can be fitly closed without a leaf from your own experience, Mr. Chairman. I believe you have the largest flock of sheep of any man in Massachusetts, and I am sure the audience would all like to hear from you.

The CHAIRMAN. Well, gentlemen, I should be very glad to give you the result of my experience, but I think most of you have heard the oft-told tale. I should corroborate a good deal that Mr. Avery has said. One question that was asked was about ventilation. The principal rules of successful sheep husbandry are, that the sheep must be kept cool and dry, and have enough to eat. That is the whole secret of sheep husbandry. "And running water" is suggested by the essayist, which goes without saying. On that subject of water, I think few people will believe the amount of water that a hundred-pound ewe with a lamb by her side will drink. I unfortunately was dependent for water for a flock of some three or four hundred ewes on a windmill; the wind didn't blow for five or six days, the thermometer went down below zero, and it was a very difficult job to haul water for those sheep. I had one or two ewes with lambs by their side in a small pen, and I found that, on the average, they would drink between five and six quarts of water a day.

With regard to keeping mutton sheep, there has always been an idea, I think, in this part of the country, that it was only the Merino that would stand running in large flocks, and when I first began I was told that I could not keep more than twenty or thirty together; but I gradually increased until I have kept a flock as large as four hundred together in a summer pasture, feeding them grain. To top-dress my pasture and kill the undergrowth, I kept the pasture overstocked. I have kept them from early in May until October on the same feeding ground, the same flock together, and with no more disease than you would naturally expect from hurdling as I do at night. I have adopted that plan with pastures which were becoming run out, grown up to bushes and covered with moss. I hurdle my sheep at night for two reasons. One is to top-dress the part of the pasture which needs it most, and, secondly, as furnishing protection against dogs. I never have had a dog jump over a hurdle.

QUESTION. What do you build your hurdle with?

The CHAIRMAN. Merely take an eight-foot section of an ordinary picket fence, and two inches from the end of the two-by-three stick to which your pickets are nailed bore a hole, then put your sections together like an old Virginia rail fence, and where the holes come above one another put in a piece of bent iron or a five-inch spike, and your fence is very strong and very easily moved.

Mr. Avery also said that sheep needed constant care, and they do. The labor is very light. There is very little hard labor in looking after sheep; but it is that very looking after, the master's eye, that covers what is called generally "good luck." There is no such thing as good luck. It is good care; and in no branch of farming that I know of does good care go further than in looking after a flock of sheep. One trouble that I have had in hurdling as closely as I do, three or four hundred in a small hurdle, is that they get very foul in the feet, and are apt to get foot-rot. The master's eye, if he exercises good care, sees when they are let out of the hurdles in the morning that there is a sheep or lamb affected in that way, and when they are hurdled again at night that sheep or lamb must be removed, and the disease not allowed to get into the contagious state. In that way it can be checked very easily.

QUESTION. How?

The CHAIRMAN. There are various prescriptions in the books. Our former secretary's sheep dip is first-rate for foot-rot. If too strong it will take the skin off of a man's arm, but if it is put on of the proper strength it will cure the foot-rot. Then there is the prescription of verdigris and carbolic soap in the old books.

I should disagree with Mr. Avery, if he will pardon me, with regard to the expense of keeping sheep. I think he has got it too high, particularly in the item of hay; because I have found by actual experience that the highest-priced hay, that is, the best quality of hay, is not so eagerly sought after by sheep as a poorer quality. I have tried that experiment by using a stack of very poor meadow hay, so poor it was hardly worth putting in the barn. I found that when my sheep had become used to it, say after feeding it two or three days, they would leave early-cut rowen and hunt up those old brakes. Of course, to keep them in condition and to keep a flow of milk for the lambs, that feed must be supplemented with a grain ration. And another thing that reduces the expense of keeping a sheep for the whole season is, that, where ten years ago it used to take about three months, more or less, to get a lamb ready for market, now, by using a sire of one of the improved Down breeds, with a good grade ewe, well fed, you can as often market a lamb under fifty days as we used to do it in a hundred days.

Mr. GRINNELL. What age or size lamb do you find the most marketable?

The CHAIRMAN. Our local market in Boston is not active for lambs until into February. There may be occasionally one asked for before that, but as an ordinary rule the market for lambs does not open until into February, and at that time lambs will be taken weighing from twenty-five to twenty-eight pounds, which, bred from improved sires on good grade ewes, ought to be put into the market at six weeks' old.

S. E. STONE. I would like to ask one question in regard to pasturing sheep. Is it desirable or proper to keep sheep continually on the same pasture?

The CHAIRMAN. They do better to change. I merely stated that as an exaggerated system. I have tried that, and tested it very carefully. I propose to cut my pastures up into five or six, and let the sheep run ten days in one and ten days in another.

QUESTION. How many sheep can you feed on one acre, as compared with one cow?

The CHAIRMAN. From eight to ten.

Hon. J. E. RUSSELL. You might have stated that the buyers in Boston want lighter lambs than they used to. They will buy lambs weighing from twenty-two to twenty-five pounds, when they used to insist upon having a lamb weigh thirty or thirty-five pounds.

The CHAIRMAN. When I began it took me from seventy to eighty days to get lambs that would dress twenty-five pounds. I can now do it easily in forty days.

Adjourned to two o'clock.

AFTERNOON SESSION.

The meeting was called to order soon after two o'clock by Mr. WOOD, who said: —

The subject of this afternoon's lecture is "Fruit Growing." We have to speak upon that subject a gentleman whose successful experience for more than thirty years in growing the fruits of New England has been an object lesson to the neighbors in the vicinity where he lives. I have the pleasure of introducing to the audience Dr. FISHER of Fitchburg.

FRUIT GROWING: ITS DEMANDS AND ITS ENEMIES.

BY DR. JABEZ FISHER OF FITCHBURG.

In considering this subject, it is not my purpose to attempt to cover all the ground that the title might seem to include, but rather to treat of a few of the more important points that I desire to emphasize, which, though essential to success, yet are apt to be neglected or overlooked. There are a number of excellent treatises in the market which give full and explicit directions for all the conditions and manipulations required for the growth of an orchard, vineyard or other fruit plantation. I prefer to begin by considering the especial demands of the plant when full grown, and ready for the production of a crop of fruit.

Suppose we take an apple orchard of this description, covering an acre of land, and inquire if it has at its disposal all the elements of fertility required for full fruitage. What is the amount of plant food rendered available by the unaided forces of nature during a year? Is it sufficient for the purpose, or must it be supplemented by art? Every neglected orchard in the Commonwealth contains within itself an answer to this last question. They virtually say, "We are starving; without help we can do but little; feed us, and we will feed you."

Let us inquire how much fertility can be permanently depended upon without any additions to the soil. We may obtain from the grass crop an explicit answer to this inquiry. Fair, average upland, fit for orcharding, will yield continuously, one season with another, without cultivation or fertilizing, we may say two-thirds of a ton of hay. I think this to be a generous estimate. The average yield of all the hay in the State for the ten years 1880–89 inclusive is 1.09 tons per acre, as given in the "Album of Agricultural

Graphics," for 1890, published by authority of the Secretary of Agriculture. For the whole country the average is 1.19 tons. This includes all the hay, whether cared for or neglected. My own impression is that half a ton would be nearer the actual, natural product of average lands; yet, that we may not be led astray by an under-estimate, I will call it two-thirds of a ton. Now, what are the more valuable constituents removed from the soil by this amount of product, — those which are soonest exhausted and which tax the soil to its limit? According to Prof. C. A. Goessmann, there would be required, in round numbers, 4 pounds of phosphoric acid, 12 pounds of nitrogen and 16 pounds of oxide of potassium. How far would these substances go towards supplying the requirements of a crop of apples?

An analysis furnished by Prof. J. W. Clark of the Missouri Agricultural College Experiment Station, in Bulletin No. 10, gives the ash constituents of the Ben Davis apple, from which it appears that a crop of 300 bushels would remove from the soil, in round numbers, 4 pounds of magnesia, 7 pounds of lime, 7 pounds of phosphoric acid and 43 pounds of potash. This, it must be remembered, is for the fruit alone of a very moderate yield. If we add to this the amount of these same substances permanently stored up in the growth of the roots and branches, and also that contained in the foliage, which may or may not be retained as it falls upon the surface of the soil or is blown away by the winds, I think I shall be justified in estimating that the least quantity of phosphoric acid and potash essential for the production of a full yield of apples would be 14 pounds of the former and 80 pounds of the latter. If, as shown by a grass crop, the natural forces will furnish but 4 pounds and 16 pounds of these substances respectively, then it follows that art must supplement nature by 10 pounds of phosphoric acid and 64 pounds of potash, or be satisfied with less than a full production.

It is a source of regret that we have as yet so few analyses bearing upon matters of this kind that no absolutely certain conclusions can be drawn from them; but it is hoped that, through the large number of experiment stations now in active operation, these and many other vital questions will be so flooded with light that the data furnished thereby will be beyond doubt or cavil.

As the result of a good deal of study in connection with many years of experiment, I am fully persuaded that not less than an annual addition to the acre of average land, in some form, 25 pounds of phosphoric acid, 30 pounds of nitrogen and 75 pounds of potash, together with some lime and magnesia, is absolutely demanded for the production of a full crop of apples; and that, with such addition only, no removal of other product than the fruit alone is to be tolerated. The relative proportions of these ingredients need not vary materially for other fruits, but the quantity may be profitably increased for the pear and the strawberry.

In order to meet this demand, I have gradually evolved a formula which for 1891 had the following composition, and, unless new light causes a modification, will be essentially the same for 1892: —

	Pounds.
Cotton-seed meal,	200
Muriate of potash,	140
Nitrate of soda,	60
Sulphate of ammonia,	40
Sulphate of magnesia,	40
South Carolina floats,	70
Plaster,	70
Total,	620

The net cost of these materials last spring delivered at the railroad station was about $11.

This is to a considerable extent a theoretical application as regards the amount to be applied, but we have a practical guide for its use or for the use of any other. If an orchard is in a healthy condition there should be a general growth of new wood, from a few inches in old bearing trees up to twelve to eighteen inches in trees carrying their first fruits. The leaves should be large and of a dark-green color. If the growth is excessive, a portion of the fertilizer may be withheld; but, if it shows the least falling short, the amount should be increased.

A somewhat near approach to this formula in composition would be found in 20 bushels of good ashes and 200 pounds of nitrate of soda; but I think it would cost more and be considerably less valuable. For those who do not care to mix their own materials, I presume that our fertilizer manufacturers would be glad to furnish them to order, in the proportions of constituents here indicated, already combined. The reason that such a compound is not now offered for sale is a plain business one. There is no call for it. It is not for these dealers to educate or lead public opinion, unless there is money in it. The moment a demand comes they will prepare themselves to respond to it. I have no doubt that the dealer who will first provide formulas more consonant with the results of chemical analysis will be the first to be able to publish testimonials tending to advertise and enlarge his business in consequence.

The time for the application of fertilizing material is in the spring, as soon as the land is free from frost and surplus water. It should be spread broadcast and evenly over the entire surface ; and we are then ready to anticipate the phenomena of that wonderful, annually recurring miracle, — the active resurrection of the vegetable world.

No sooner, however, does this commence, than we are confronted by a multitude of insect enemies. I shall here mention only a few out of the many, those whose depredations are the most serious : the tent caterpillar, the curculio, the codling moth, in some localities the bud moth, the canker worm, the pear-tree psylla, various forms of aphis, and, later in the season, the apple maggot and the web worm. It is pretty evident that these enemies of ours have acquired by possession a fee simple of our premises, and are prepared to remain with us. Some combination of seasons or some parasitic enemies of theirs may so far aid us as to reduce their injurious effects to a minimum for a year or two, but we cannot hope to bid them good-bye. Whatever fruits we obtain we must fight for ; and it behooves us to become acquainted with the tactics of our enemies, and provide ourselves with effective weapons and materials for defence.

The tent caterpillar (*Clisiocampa Americana*) is a familiar insect that attains its mature condition and lays its eggs during the month of July, in a ring encircling the smaller twigs of the apple and wild cherry. These eggs hatch about the time of the swelling of the buds, and the hairy worms or caterpillars form a silken web or tent, under the shelter of which they spend their time, except when feeding upon the young leaves. They are very easily destroyed, as they are found for the most part upon the lower limbs within easy reach, and, while young and small, are readily removed and crushed between thumb and finger or under foot. Their webs are plainly seen when the sun is near the horizon, and a few hours' work at the right time will rid a large orchard of them for the season. Cool mornings and evenings will find them all at home when visited. Notwithstanding the ease with which they may be destroyed, hundreds of trees have been completely defoliated by them during the past season. This neglect on the part of the owners is a fine thing for those who take pains and give their orchards a little attention, because it tends to diminish the supply and thus enhances the price of the fruit. The only drawback is found in the enormous crop of caterpillars which our neighbors thus provide for our comfort the next year. Spraying with arsenites, as will be explained further on, is an effective remedy as a supplement to hand picking.

The curculio (*Conotrachelus nenuphar*) is an insect that appears early in the season, probably before the fruit is formed, and to some extent feeds upon the foliage as well as upon the fruits in making the crescent-shaped puncture in which the egg is laid. It is difficult otherwise to account for the useful effects of early arsenical spraying in arresting its depredations. Aside from spraying, it is best controlled by jarring the trees and catching the falling curculios upon a large cloth, from which they are easily gathered and destroyed. The best mode of jarring is by striking a smart blow with a hammer upon the end of a small iron plug inserted in the trunk or large limbs of the tree. This operation should be begun as soon as the presence of the insect is detected, and continued once or twice daily as long as any are captured. The jarring process is more especially valuable to the grower of plums, as by a systematic repetition for two or three weeks a complete saving of the crop may always be assured. As the plum is prone to bear heavy crops under favorable circumstances, some growers consider the curculio as a friendly insect, inasmuch as its work causes a large number of specimens to drop from the trees, thus thinning the fruit, — an operation which the careful cultivator would do by hand. I think, however, that in most cases where a person employs the curculio to do his thinning, he will find himself but poorly served, as frequently a good appetite and a lack of judgment on the part of the employee will result in the removal of the last specimen.

The codling moth (*Carpocapsa pomonella*) has been one of the greatest pests of the fruit grower for many years. This is the insect that produces most of the wormy apples and pears. In years of scarcity it is difficult to find specimens free from its depredations, and it is only when the crops are large that the limited number of worms find more apples than they can conquer. This insect in the pupa state hibernates during the winter in cracks, in the rough bark of trees, in fruit rooms and wherever apples are stored, and comes forth as a perfect insect about the time that the trees are in bloom. The female lays her eggs for the most part singly within the calyx of each apple or pear. The worm hatched from this egg feeds upon the surface for a short time, and then makes its way into the substance of the fruit towards the core. After arriving at maturity it emerges from an opening previously made, generally at the side, thus leaving a hole that detracts from the value about one-half. There are two broods of this insect in a season, the first one causing the fruit to drop from the trees early, while the second is responsible for the wormy winter apples. From this circumstance we may see the importance of suppressing the first brood, that the injury caused by the second may be prevented as much as possible. Aside from arsenical spraying, many of the pupæ may be trapped by bands of cloth or paper wound about the trunk of the tree, from which they may be gathered at stated times and crushed. The presence of hogs or sheep in an orchard will give the quietus to many, though as a rule I think the worms leave the fruit before it drops from the tree.

The canker worms (*Anisopteryx vernata* and *pometaria*) were formerly very serious pests, but at the present day the remedies at our command and in use for other insects leave no excuse whatever for their continued presence, and I will therefore pass them over.

The bud moth (*Tmetocera ocellana*) is an insect that has done much injury to fruit trees in some parts of the State, without being generally recognized. It differs from most other insects in that it requires a part of two seasons for its growth while in the larval stage. Its history is given by Prof. C. H. Fernald, in Bulletin No. 12 of the Hatch Experiment Station, from which it appears that the moths emerge between the last of June and the middle of July or later, when they pair and lay their eggs upon the leaves. The young larvæ, which are at first of a creamy white color, with a brownish head, grow gradually to be of a darker color, eat minute holes in the leaves, and keep themselves within a silken web spun upon the leaves near the midrib. As the leaves fall in autumn, the larvæ are carried with them, and, unless blown away, hibernate during the winter under the trees. In the succeeding spring the half-grown larvæ make their appearance as soon as the buds begin to swell, and eat their way into the substance of them, which causes their destruction. Each larva as it grows requires a number of buds, and afterwards draws the leaves together, continuing its destructive work, but all the time keeping out of sight. As it approaches its transformation it attains a dark, brownish color, with a darker head. From the middle to the last of June it draws together several leaves, which it lines with silk and within which it transforms to a pupa. This promises to be a difficult insect to deal with, on account of its habit of secreting itself within the early buds, and later between the leaves. The best mode of attacking it would seem to be either to prevent its ascent of the trunk of the tree by some obstacle, or to destroy the larvæ among the fallen leaves by fire or otherwise.

Later in the season, and extended over a considerable time, the fruit trees and the fruits involved are much disfigured by the work of the fall web worm (*Hyphantria textor*). These worms extend their web as they grow, so as to be at all times enclosed and protected in their development. They are easily removed when young, as a large colony occupies then but a little space, at first a single leaf only. They are generally unseen, however, until the size of their web attracts attention, when, if confined to a small twig, the whole is readily removed. Otherwise it is not easy to dispose of them without considerable trouble.

An insect known as the apple maggot, or railroad worm, (*Trypeta pomonella*), from the track which it makes in the apple, is the cause of much loss to the grower, more especially in early fruit, though it is occasionally found in winter varieties. The insect deposits her eggs during the month of July, choosing for the most part the thin-skinned varieties. On arriving at its growth it leaves the fruit, which remains on the tree, and burrows into the ground to enter the pupal state, where it remains until the next summer. From its habits it is evident that the opportunities which it offers for attack are not encouraging. We are not aware of its mischief until it has put itself out of harm's way.

In some localities the pear trees have been subject to a very destructive enemy in the shape of a kind of aphis, which, from its habit of apparently jumping when disturbed, is called the pear-tree psylla (*Psylla pyri*), or jumping louse. Its habits have not been thoroughly studied. It is the cause of what is known as honey-dew, and is accompanied with a form of leaf-blight. Growth ceases, the leaves become spotted and fall from the trees, and the wood, covered with the sweet, thick liquid, attracts thousands of bees, wasps, flies, etc. The wood gradually grows very dark-colored, nearly black, which color remains until the insects cease their depredations. The fruit upon the trees, for want of healthy foliage, is small and poor, and unless relief comes the destruction of the trees is to be anticipated. According to some authors, the eggs are laid in the autumn upon the ends of the twigs. If this is correct, the eggs may probably be destroyed by spraying the trees with a strong kerosene emulsion. In my own experience, however, during the past season, the mature insect suddenly appeared about the 8th of June in considerable numbers, and honey-dew was first seen a few days afterward. I sprayed with the emulsion June 10 to 12, and again from July 17 to 22. Soon after the second spraying I observed that the secretion of honey-dew was largely suspended, and later that the foliage seemed to take on a more healthy action. Eggs and larvæ were found in considerable numbers upon the leaves, but they acted in a very sluggish way, and a large portion of them eventually disappeared without development to maturity. What the future is to bring about in regard to them is as yet an unsolved problem, and what precautions should be taken I am at a loss to know, on account of the want of a full knowledge of their habits.

I come now to the subject of insecticides, by means of which we are enabled to exterminate, suppress or minimize the insects and their injuries. For this purpose the various insects may be divided into two classes, known as leaf-eaters and sap-suckers. Their habits are so different that an agent that would be fatal to one is of no value in the case of the other. For the class of leaf-eaters, nothing has been brought forward equal in value to arsenic in some form. If this substance is spread upon the leaves, the insect in consuming them is obliged to take the poison, and is thus destroyed. The result of multiplied experiments in the past few years has developed the fact that for this purpose the arsenic must not be in a soluble condition. If it is, it cannot be applied in sufficient strength to kill the insect without seriously injuring the foliage. This rules out arsenious acid, which is the common white arsenic, as it is entirely soluble in water. London purple, which is a compound of arsenic and lime, is to a considerable extent soluble and open to the same objection in a less degree only than the white arsenic. We are therefore obliged to fall back upon Paris green, which is a compound of arsenic and copper. This is in the form of an exceedingly fine precipitate, and is entirely insoluble in water. It is a very heavy substance, which settles at the bottom of the liquid in a brief time, and requires almost constant agitation to keep it in suspension while being used. This mixture is applied by means of something that will deliver it in a very fine spray, so as to wet the entire foliage, each tiny droplet of water holding in suspension one or more particles of the poisonous arsenite. The water at once evaporates, and leaves the poison upon the surface of the leaf, where it remains some days unless washed off by rain.

It is of course entirely inappropriate to make use of this agent before the foliage begins to develop, as at that time no insect will be affected by it. It might be supposed that the bud moth could be reached among the fallen leaves of the previous year; but we shall not be able to induce him to take the medicine until he ascends the tree and begins to feed upon the swelling buds, and even then he is exposed but a very brief time before burying himself within their substance. The tent caterpillar, however, and the canker worm, among others, are very early on hand, and are both amenable to the poison. In the presence of the canker worm an application should be made as soon as they are found at work, but for the caterpillar alone I prefer to depend upon the thumb-and-finger remedy, using the spray only to cover the neighborhood of nests that are out of easy reach.

The first general spraying, unless canker worms are present, should be made just before the opening of the blossoms. This spraying might possibly be dispensed with; but, as I shall a little later recommend spraying at this period for another purpose, I would use the green at the same time. At this time the bud moth is present, and perhaps partially amenable to the action of the poison, together with various leaf-eating insects; and I suspect that early specimens of the curculio and codling moth are on hand in sufficient numbers to make it desirable.

The next spraying with Paris green should take place as soon as the greater part of the petals have fallen, and this is the one which is the most important, and the good effects of which are most manifest. At this time the curculio and the codling moth are appearing in full force, and it is exceedingly probable that they both, though in the winged state, do consume some of the foliage, and take bites out of the skin of the fruits, which grow into deformities, during the time of pairing and egg laying. Experience certainly demonstrates that spraying at this time is more valuable than later. The operation should be twice repeated in from seven to twenty days afterwards, in order to give all the belated insects an equal chance with their more enterprising brethren. If the green is not washed off within forty-eight hours, it need not be immediately replaced, but otherwise it should be at once repeated. As a general rule, if not interfered with by rains, I would aim to spray three times after blossoming.

Kerosene as an insecticide acts in an entirely different way from Paris green. It kills by contact, and is especially appropriate for all lice, thrips, red spider and other insects of that character, and to some others. Any insect immersed in kerosene is at once deprived of life, and so are all growing plants; but, by finely dividing it into a mist or dew, it still retains its power as an insecticide, without endangering even tender plants. This division is brought about by emulsifying the kerosene. For this purpose dissolve half a pound of yellow bar soap in one gallon of water. When it boils, pour into one vessel this solution and two gallons of kerosene. By means of a force pump or syringe mix the whole with some force. In from three to five minutes it becomes a white, creamy emulsion, in which the kerosene is visible only in tiny drops. This condition remains nearly permanent for some days, especially if kept in a cool place. A quart of this compound, added to nine or twelve quarts of water and well stirred, will still keep the form of an emulsion for a short time, and give the proportion of one part of kerosene to fifteen or twenty parts of water, which is about right for all out-of-door use. This is sprayed upon the foliage so as to wet the insect operated on, and its effects are fatal at once. The water and the kerosene soon evaporate, leaving only the film of soap, which is washed off by the first rain. This insecticide is appropriate at any and all times and places where minute insects are present, especially all the varieties of the aphis family, — the weaker solution on all tender foliage. The soap in the emulsion prevents the use of Paris green or any compound of copper at the same time.

Having in a somewhat imperfect manner considered some of the more important insects that threaten the interests of the fruit grower, I come now to a class of enemies that at times is a more serious menace than the other. I refer to the various forms of fungous growths or diseases that have in the past few summers been so increasingly destructive in various ways by producing blights, mildews, rots, rusts, etc. Foliage and fruits seem to be equally open to attack, and in many cases there is brought about an almost or quite total failure of crops over extended sections. The seasons most favorable to large crops are also most productive of fungous troubles, on account of the abundant rains and the accompanying heat and humidity of the atmosphere at such times. A succession of them, such as we experienced from 1886 to 1890 inclusive, gives to the various fungi an immense advantage as time goes on, for the reason that the spores or seeds live over winter, and are thus in condition for begining the following season in larger and larger numbers. One summer of drought will largely retard or prevent the development of many fungi, and two dry seasons will reduce their injuries to a mere fraction.

In newly settled regions, where the various fruits are cultivated on a small scale, they are mostly free from attack. Also in cities and towns they are apt to escape, partly because of the shelter afforded by buildings and other structures, and doubtless on account of the sulphurous gases given off from burning coal. Wherever one or more large plantations of one kind of fruit occupy the ground, sooner or later the various fungi, as well as destructive insects, will there find a fit home; and it is only by the use of artificial remedies that we can defend ourselves against their depredations.

It will be interesting to consider for a moment under what circumstances fungi make their appearance and attain development in spring or summer. The spores or seeds which have lived over winter are liberated in the warmth of the season and the decay of the fallen leaves and other debris. These microscopic bodies float about in the atmosphere, and some of them rest upon the living foliage or other part of the plant. So long as they remain dry, no action occurs; but, if they are moistened and remain wet for a few hours, they vegetate and insert what may be called their roots into the substance of the bark, foliage or fruit, from which time they are able to continue development independent of outside moisture. They go on rapidly to maturity, and produce multitudes of spores which float off and attach themselves to other spots, and under favorable conditions multiply enormously.

I have stated that spores do not vegetate so long as they are kept dry. In proof of this may be cited the fact that in time of drought these troubles occasion but little loss.

Again, in localities that have a dry season throughout the period of growth, these maladies are not prevalent. The effect of an awning of boards or cloth over a single trellis in a vineyard is a complete protection to the foliage and fruit underneath it, even where that of the vines on either side is destroyed. This is not because the covering prevents the deposition of the spores floating in the atmosphere, but for the reason that no water from rains and more especially from the deposit of dew can take place under such protection. Rain is probably not nearly so favorable for the spread and propagation of fungous spores as are dews and fogs. The effect of rains is most likely to remove the spores by washing them off upon the ground before germination, where they can do no harm until by drying out they may be in condition to renew their aerial flight. The effect that follows the enclosure of grape clusters in paper bags goes to prove the same thing. If this operation be performed before the germination of the spores of mildew or rot, the clusters are perfectly protected throughout the worst season; but, if it is done only one day too late, the protection is of little or no avail.

Many years ago sulphur was looked upon as a sovereign remedy for most of these mildews and blights. Perhaps this idea arose out of the theological teaching of the times; but in both cases it has been learned that it is ill adapted for the highest ends, while other appliances have been found to be an adequate and preferable substitute. As the matter stands to-day, the agent which surpasses all others in the effective treatment of fungi in general is found in some form of solution containing copper. Other substances, such as soluble arsenic and corrosive sublimate, are known to be valuable for the purpose; but no one combines within itself so many good qualities, and we can hardly ask for one that will give more satisfaction in its effects. It is very cheap, in no way dangerous to use, easily applied; and while, when properly used, it does no injury to cultivated plants, it is preëminently destructive to many if not most forms of fungi. One part of copper in solution in upwards of a million parts of water will entirely prevent the development and growth of these minute organisms when immersed in it, and a stronger solution will undoubtedly kill the spores.

Various forms and compounds of copper have been and are in use. The sulphate, known both as bluestone and blue vitriol, has been employed, but at any strength of solution recommended has been found destructive to the foliage. In order to overcome this objection, it has been combined with lime, which is of itself a weak fungicide, and this combination is now known as the Bordeaux mixture.

This seems to me to be a very unscientific preparation for the purpose designed. Both substances, when in solution separately, are undoubtedly fungicidal in their action, but when combined they form by a double decomposition a sulphate of lime, which is simply gypsum or plaster, and the oxide of copper, an entirely insoluble substance. Either one has destroyed the nature of the other, and rendered it for our purpose almost completely inert. Six pounds of sulphate of copper are directed to be combined with four pounds of lime, the latter being in excess, as it should be; and this amount, used with twenty-two or twenty-five gallons of water, is to be sprayed upon the foliage. A theory of its action is that its presence upon the leaf by preëmption mechanically prevents the fungous spores from fixing themselves upon the same spot, and there developing. I have no doubt that this idea is in part correct; but, in order to be fully protective, the substance must necessarily be applied to the entire surface of every leaf. I have seen mildew develop freely upon grapes completely surrounded within three to five inches by a thick spray of Bordeaux mixture that had been applied some weeks before, and that the rains had not washed off. Another theory which looks more reasonable is, that, as sprayed upon the leaves, the substance acts as a store-house of oxide of copper, which is very slowly soluble by reason of the small amounts of carbonic acid and carbonate of ammonia found in rain-water, and so the copper becomes active in exceedingly minute quantities.

Another combination, known as Eau Celeste, or blue water, is one in which the sulphate of copper in solution is treated by adding liquid ammonia. The product is sulphate of ammonia and oxide of copper. The ammonia, however, being in excess, dissolves the oxide of copper, producing the deep-blue color. This is sprayed upon the foliage, as in the case of the Bordeaux mixture, but in a state of complete solution. As soon as the ammonia evaporates, which is very quickly, the insoluble oxide of copper only remains. The action of other preparations in which the carbonate of copper is dissolved in either caustic ammonia or the carbonate, is almost precisely similar, the carbonate being as insoluble in water as the oxide. They are applied in a state of solution, but become at once insoluble as soon as the moisture is fully evaporated.

Notwithstanding the unscientific character of these various preparations of copper for the purpose in view, there is no question but that much good has come out of their use, although the results contain a good deal of contradiction among themselves. I think it possible to reconcile some of these, but do not care to occupy your time to speculate upon the subject now. In their place I venture to propose, as a complete substitute, the use of the simple solution of sulphate of copper. It is free from most of the objectionable features that apply to other preparations of this metal. Its operation as a fungicide is decided and unquestioned. The substance readily dissolves, and is in no way detrimental if properly applied, either by its present or ulterior effects, and does not disfigure the foliage. The only difficulty heretofore has been that it was used at such a degree of strength as to act as a caustic, and thus destroy more or less of the substance of the leaves to which it was applied. This is easily avoided, although it has been a matter of much careful experiment to ascertain the strength at which its ill effects are entirely wanting. It has this peculiarity, that it does not show all of its injurious action for some days or even weeks after application, and we are therefore liable to be misled in its use. Although my experiments, more especially during the past season, need repetition and verification before too much confidence is based upon them, I feel prepared to recommend, as the best general fungicide now available, a solution of sulphate of copper, one pound to eight hundred gallons of water, two ounces to one hundred gallons, one ounce to the barrel of fifty gallons. So far as I have learned, no injurious effects have followed from an application of this strength, while as a fungicide it contains one part of metallic copper in upwards of twenty-six thousand of water, — more than thirty-eight times the strength incompatible with fungous life when immersed in it. It is altogether probable that a much weaker solution would answer every purpose, but that is a matter for future experiment to determine.

I have not had an opportunity to make use of this solution upon all kinds of foliage, as I could have wished, and more especially in its younger and tenderer stages; but the most susceptible that I have found thus far has been that of the peach. One pound to four hundred gallons will scald these leaves and cause them to drop from the trees to some extent in midsummer; but at half this strength, one pound to eight hundred gallons, there is no apparent injury at that season.

The question of what fungicide to use having been settled upon, it is of much importance to consider the times and mode of making the applications. Perhaps the best I can do is to give my own programme for 1892 as it comes to me to-day, but liable to be modified by the experience of other observers yet to be published. I will also include in this the use of insecticides, as the treatment for insects and fungi are often combined in one operation.

The first day in the spring, when things are sufficiently dry, all the dead foliage, grass, weeds and rubbish, are to be collected and burned. This operation will dispose of innumerable winter spores of various fungi, and also no doubt the bud moth of the apple. Just before the buds swell I propose to spray the trees, vines, trellises and the ground underneath and around them, where the fire has not run, with a solution of sulphate of copper, one pound to one hundred gallons. At this time there is no foliage to be injured, and the solution may be made as strong as we desire; but I think that this would be as useful as a stronger one. After the development of the leaves, but just before the blossoms open, I shall spray with the copper solution one pound to eight hundred gallons, to which will be added Paris green in the proportion of one pound to two hundred gallons. The two substances may be used together, as there is nothing incompatible between them, and they do not interfere with each other in any way. Immediately after the bloom, even before the last petals have fallen, the spraying will be repeated, using both substances. In the seven to twenty days following, the same application will again be made at two different times. This applies more particularly to the apple and the pear, and modifications will suggest themselves for other fruits. For grape vines no Paris green will be needed. The last-mentioned spraying will complete the round, unless the season shall prove to be one of unusual fungoid development, in which case the copper spraying will be repeated whenever it will be likely to be of service in arresting the progress of any one or more fungi.

If I am asked whether all these several operations are equally essential, I answer No. I consider that the burning and the first spraying, previous to the appearance of the foliage, are more important than all the others combined, so far as they relate to fungi. If we could exterminate every winter spore, we should have no development of the summer growth. It is very much easier to prevent these maladies than it is to cure them. They all arise from spores or seeds, as much as do plants of purslane or corn. "Whatsoever a man soweth," or permits to be sowed, "*that* shall he also reap." In the matter of insects I think the spraying at the close of the bloom to be the more important; but all that I have mentioned are desirable, and will liberally pay their cost. Under this treatment I shall expect to find that the losses by either fungi or insects will be reduced to the minimum; and by an annual repetition, in the absence of ignorant or negligent neighbors immediately west of me, I shall hope to remain comparatively exempt in the future.

The application of insecticides and fungicides in a water spray has developed many contrivances for the purpose. As might be expected, some of them are more ingenious, elaborate or expensive than useful. Inventors are not often fruit growers, nor are the latter inventors. The different conditions required are comparatively simple by themselves, but in combination are difficult or impossible of attainment. What might be described as the perfection of the process would be the finest possible division of the water, to be deposited like dew upon every part of the foliage. This is brought about by the druggist's atomizer, which, however, reaches but a foot or two. Then we have the cyclone or Riley nozzle, which covers a distance of three or more feet. The Vermorel nozzle will throw from four to six feet. It is to be noticed that, as the distance increases, the spray necessarily grows coarser. The Nixon nozzle reaches some six or eight feet, and the adjustable somewhat farther. The two latter require a strong force-pump for their working. It follows that the finest spray and the greatest distance are quite incompatible with each other. To overcome in a measure this objection, the nozzles have been attached to the end of a stretch of hose and supported by a long handle.

During the past season I used a force-pump fastened to a barrel, transported on a stone boat. I attached an adjustable nozzle to a piece of hose twenty feet long, and supported it by means of a light handle twelve feet long. The nozzle was so placed as to be at an angle of forty-five degrees from the handle, so that it should be easy to cover any and every point. After sundry breakdowns, and delays in consequence and various amendments, some of them requiring the assistance of skilled workmen, it was made to do fair service, but never worked to my satisfaction. It required three men: one to manage the spray, one to drive the pump and one to handle the horse. It might be supposed that the last mentioned could be dispensed with, but I found that he was the most important man of the three. It was his duty to keep the apparatus in such motion as to allow every part of the tree to be wetted, and yet move along fast enough so that no part was drenched or over-supplied. My position as an outside observer showed me that, with all of their combined skill, the spray was quite unevenly applied. Parts of trees were flooded and other portions left dry. Superficial observation was pleased with the apparent rapidity and amount of work done, but careful examination showed that the quality was by no means such as would best bring about the end sought. In using the Bordeaux mixture the arrangement for keeping the solid matters in suspension was not efficient for the purpose, so that the greater part of the material was left upon the first trees sprayed, and that remaining in the barrel was all the time growing weaker. Paris green, which is a heavier sediment than that going to make up the Bordeaux mixture, must necessarily behave in the same way; but there would be nothing to show it upon the trees. The men did not look upon it as a holiday implement or appropriate for holiday garments, and I concluded that perfection lay farther on.

I was thus led to inquire whether a simpler and less expensive affair, adapted to the wants and means of the small grower as well as of the more extensive orchardist, could not be devised that would better answer the end sought. What was required of such a machine was that it should throw water twenty feet or more, in as fine a spray as was compatible with such a distance, and that would perfectly respond to the eye and the judgment of the user. After much experimenting on this line, I have settled upon a plain, brass hand syringe, which has the following points.

The barrel is made fifteen inches in length, with a stroke of fourteen inches, which is long enough for people in general. It has a diameter of one inch and three-fourths, and will hold more than a pint at a filling. The rose or nozzle is pierced with holes of such a size that a moderate effort will throw the water twenty feet, and twenty-five feet is attainable. This distance is either horizontal or perpendicular, the height of the nozzle above the ground in the latter case compensating for the effect of gravity. The number of holes is ninety-nine, which is about three times the usual number in ordinary syringes. The direction of each of these holes is radiately from a point in the rear of the nozzle, and the ultimate spread of the spray is about six feet.

At my solicitation the well-known firm of Robert T. Deakin & Co., corner of Twelfth and Buttonwood streets, Philadelphia, Pa., has consented to manufacture and supply orders for this syringe, to be known as the "hydrosprayer," the advantages of which may be thus stated. It is low priced, considering its excellent workmanship and substantial make-up. If not obtainable at the agricultural and seed stores, it may be ordered direct of the manufacturers. The retail price will be $5. An attachment comprising a combination stream and cyclone nozzle will be furnished for seventy-five cents extra. This latter will be found invaluable for use in the spraying of plants under glass or in the garden, with either plain water, or in applying fungicides and insecticides perfectly and economically, and should be in the hands of every grower of plants.

This hydrosprayer is simple in construction, and little liable to get out of order. A very small amount of skill will suffice to keep the packing in perfect shape. The spray is as fine as that of the adjustable nozzle of the force-pump. It will reach every portion of a tree within twenty-five feet. It is in no sense unduly fatiguing when used continuously. It is especially adapted for Bordeaux mixture or Paris green, as with each filling the materials may be kept in a most perfect state of suspension.

It is used in this way. The liquid is transported in a barrel standing upright upon a stone boat. The operator dips out a three-gallon pailful, first stirring if necessary, and places it by the side of the tree to be sprayed. If Paris green is to be used, it is then added. A level teaspoonful of the green, weighing just one-fourth of an ounce, is the right quantity for three gallons of water. The syringe, employed as a stirrer, is filled and used two or three times, when the pail is moved along, and this is repeated until the tree is finished. Somewhat to my surprise, I found that the same number of men could put on quite as much water in a given time with these sprayers as could be done with the force-pump, while the quality of the work was beyond comparison.

For spraying a large number of small trees like plums, peaches or nursery stock, but especially for use in the vineyard, potato field or strawberry patch, a knapsack pump may be found desirable, on account of the convenience of transporting the liquid. These machines are made to carry about five gallons, and are worked by a small force-pump, driven with one hand, while the other directs the spray through a Vermorel nozzle as the operator walks along. The only objection that I have found to its use thus far is, that every time I employed its services it was necessary to have a tinker or a machinist with reach. Cheapness in construction, together with efficiency and durability in working, are not entirely compatible conditions. None that I have seen are well adapted for the use of Paris green or Bordeaux mixture, as they possess no efficient means of keeping the solid matters thoroughly suspended in the liquid.

Lest some of you should entertain the feeling that, in the face of all this array of description and detail, the contest is not worth the expense and the effort, and be disposed to give up the fight in advance, permit me to recall to your attention the few essential points. First, the absolute annual demand for the elements of fertility. For this purpose we shall find that it is best to be generous. Call it $15 for an acre. Second, the outfit. One hydrosprayer, $5; two pounds of sulphate of copper, one pound of Paris green, perhaps ten gallons of kerosene and a bar of soap, $1.50. Third, three days' labor, $4.50, making a total of $26, of which two-thirds or more of the price of the hydrosprayer may be credited to additional acres and future years. Does this enumeration seem forbidding? Do you know of a more promising investment for your capital or your labor? I have no doubt that every time in the last ten years I have neglected or failed to make use of the agencies herein specified, the result has shown that every dollar thus saved has cost me five in the end.

I have made no mention of the important subject of thinning fruits, for the reason that I fully considered that matter with others in an address that I had the honor of delivering before this Board two years ago. Additional experience would but emphasize all that is therein contained.

Every year our markets are teeming with inferior specimens of fruits, the product of neglected orchards and fields. If your highest ambition is to swell the supply of such, you need no advice from me, competent as I may be from sad experience to give it; but, if you are striving for the best and at the same time the most remunerative results, you will be ready to give heed to any and every suggestion that promises to further these ends.

The CHAIRMAN. You have had the experience of one of the most successful fruit growers we have in the State of Massachusetts. If he has suggested anything that has not been fully explained, or if there are any questions which you would like to ask, he will be ready to answer them.

While you are preparing to do so, I wish to say that Professor Fernald is here, and will be obliged to leave early in the afternoon to return home. He has been spending a portion of the past season in investigating the enemies of the cranberry. Although that is not so universally cultivated over the State as the fruits of which the doctor has treated, it has become an important crop of the State, and is growing more important every season. Will the professor give us his experience the past year in ascertaining and in combating the enemies of the cranberry?

Professor FERNALD. I was written to some two years ago, and asked to investigate the insects injurious to cranberries on Cape Cod. I knew nothing of the industry at that time, and supposed it to be rather a small affair, involving perhaps ten thousand dollars. I had never been down there, and knew but little about the plants; and I wrote to ascertain how much money was invested in the industry, feeling that it was my duty, as the entomologist of the State Board and working at the Experiment Station at Amherst, to put my time where it would be most valuable. I received the reply that there was a large amount of money invested in the cranberry industry on Cape Cod. That was very indefinite; but I finally went down there, and was surprised at the amount of money that was invested in the industry, and also at the amount of injury that was being done by the cranberry insects. I knew the cranberry insects; they had been sent to me; I had them in my collection; but I did not know the best method of treating them while in the caterpillar stage. I found that last year there was sent out over the Old Colony Railroad eight hundred thousand dollars worth of cranberries, and I was told by cranberry growers on the Cape that the insects destroyed half the crop. I did not know how correct that estimate might be, but it impressed itself upon me that there was a loss sufficiently large to warrant my spending time in making investigations. So last summer I spent nearly all my vacation on Cape Cod, studying the cranberry insects. I found that I had more than one insect to study. I had the fire worm, the girdle worm, and the span worm to deal with. I sent those insects to Amherst, and established a small Cape Cod bog there in the greenhouse; and, after getting those insects well established, I began to dose them. To one I gave Paris green, to another London purple, to another kerosene emulsion, and so on. I sent out circular letters to all the names I could get of cranberry growers in the State. A good many of them answered the questions I asked as well as they could. Some of the questions were quite difficult to answer. I found that most of the people were afraid of the poisonous insecticides, and they had not obtained very good results in the use of them. I experimented in this way. I measured out, with the utmost care, with very delicate balances, the Paris green, — for we have always had better success with Paris green than we have with London purple; and I found that I could kill the so-called fire worm with Paris green in the proportion of one pound of the poison to three or four hundred gallons of water. I put the insects right onto the plants; I counted them, and knew where every individual was, so that there was no missing one, and then I watched them. They drew two or three leaves together and fed inside, protected from anything that could be thrown onto them. The kerosene emulsion would not reach them, because they were closed in. They had brought two or three leaves together, had spun a silk web around them, and were as closely hedged in as possible. Then they would eat their way through the leaves. It took them twenty-four hours to do it; then they got a taste of the Paris green on the outside of the leaf, and died, every one of them. There was no failure to kill them as thoroughly as I could desire. Then I instituted a series of experiments of a similar kind upon several of the bogs on Cape Cod. I marked out certain squares, a rod square here and a rod square there, and so on, — a whole series of such patches. But I did not get the results there that I did on the bog that I had at home. I find that when I trust somebody else to do the work for me, especially if it be an elderly person, he is pretty apt to have notions of his own, and does not follow my directions so closely as I could wish.

I have grown a great many insects, in order that I might be able to tell the effect of insecticides upon them. I think "doubting Thomas" would have made a good entomologist.

There are among those insects some that I do not know. I have them now in winter quarters, passing the winter in the pupa stage; and when they emerge next year, if I succeed in carrying them through, I hope to be able to tell what they are; and then, when I get the names of them, I can look into the literature of the subject and find what other people have learned about them; and, if any of them are unknown, I shall try the thing over again, because so much money is invested in this industry that I think it expedient to spend time over this work, going slowly and thoroughly.

The essayist has alluded to my experience with the bud moth, and it may interest you to know that it took me ten years to work out the life-history of that little insignificant insect. Every year I would get round to a certain point, but there was one link in the chain of its life-history that I lost. It is a European insect, and it had been worked out there, but they had made a mistake in it by some means. It was supposed that it had been accurately done. I tried it, following out the plans which the German entomologists had adopted when they had worked upon it, but I lost the life-history at one point, and upon that link hinged the question how to destroy them. That was a necessary point, and I never got it until I threw aside all previous investigations. When I started from the first, as though nothing was known about the insect, I found out just how and where it passed the winter, and, knowing that, I could at once determine how to destroy it.

May I speak, Mr. Chairman, of some other experiments which I tried with Paris green?

The Chairman. Certainly, sir. That is directly in line with the question which we have under discussion.

Professor Fernald. It has been my experience that, when we work out the life-history of an insect to find the most available point where we can destroy it, we find that what is true of one insect may not be true of another. There was a question in regard to how much or how little Paris green would be required to destroy an insect when it is in the caterpillar stage. This past summer I took the common tent caterpillar, because that is about as healthy an insect as I know of, and it is about as abundant as anything in our region, so I could get it in every stage. I had very careful experiments performed upon them in every moult. What I mean by that is, the insect changes from the egg to a little minute caterpillar, which grows a certain time and then its skin splits and it crawls out of that; it grows larger, the skin cracks again and it crawls out of that, and so on. That is, it moults several times. This moulting is rather a critical period in the history of the insect; it is more likely to die in that period than any other. I put them on some branches of an apple tree, and put the branches in cages where the insects could not get away, and where I could see just what transpired. Then I sprayed them with Paris green in each stage or moult from the time they were hatched until they were ready to spin their cocoons. I used one pound of Paris green to fifty gallons of water, one pound to seventy-five gallons, one pound to one hundred and fifty gallons, one pound to two hundred gallons, one pound to three hundred gallons, and so on up to one pound to a thousand gallons; and they died under the application of either proportion. That is, one pound of Paris green to a thousand gallons would kill them, but it took about a week to do it. I found the most satisfactory result was when I used about one pound to three hundred gallons of water. I got as good results with that proportion as I did with any larger proportion. Furthermore, one pound to three hundred gallons of water will not injure the foliage of an apple tree in any sense whatever.

I have tried another series of experiments. (These things are not yet published, but they will appear in the bulletins of the Hatch Experiment Station.) I had twelve apple trees set out in the greenhouse connected with the insectory, which is divided into two parts. One of those parts was kept as warm and muggy as possible, while the other part was kept dry and cool, so that we might have two different climates. The apple trees were as nearly the same size as we could get them. They were set out the year before, so that they got well established. When the leaves had come out on the trees they were all showered with Paris green, one pound to one hundred and thirty gallons. It was my intention to burn the foliage, because I wanted to see what conditions of atmosphere would favor or retard the operation of the poison. I showered three of those trees by holding the watering-pot off and showering them, and the mixture was poured down at the roots of three other trees. There was no difference in the effect between the three trees showered on top and the three watered at the bottom; the difference was between the two houses. The foliage of the trees in the house where we had the hot, dense, muggy atmosphere, burned very much more than the foliage of the trees in the house that was kept cool and dry. I suppose that explains the reason why the entomologists in the West gave us in the early part of their work directions to use such a large proportion of Paris green in water as here in the East would burn the foliage very badly. I suppose it may be accounted for in that way. Here we have a more moist climate, there they have a dry climate; so that they can put on a larger proportion of Paris green than we can here, and not injure the foliage. I could not understand it before; I thought they had made a mistake, and I was going over the whole ground to see where the error was, because we want to have everything exact, so that we can know every step and be sure of the results.

There was an allusion in the lecture to kerosene emulsion, and I have tried a little of that. Indeed, I have tried a good deal of it, first and last. I put a dozen pots of roses in the greenhouse, and then I got some plant lice and put on them. Those of you who know anything about roses and plant lice know the lice will multiply with wonderful rapidity; and presently I had those roses literally covered with plant lice, — every stem and branch and leaf was covered with them, and the under side of every leaf was covered with red spiders. When I got the full growth of those insects, I made a pailful of kerosene emulsion, brought that into the greenhouse, put the roses into it, shook them there, and held them long enough to wet every part of the top. It took me from three to four minutes to do it with each pot. In two days' time there was not an insect on them. There was not a red spider nor a plant louse, nor was there any afterwards through the season. It was a perfect success. It did not hurt the foliage at all. The proportion was the same as that given by the essayist. I did not make so large a quantity, but it was the same proportion as he recommended. These are all the points that occur to me now, Mr. Chairman.

Mr. Ware. It seems to me that Professor Fernald has brought forward one difficulty in regard to the management of the fire worm that troubles the cranberry grower. He tells us he can manage them very well in his greenhouse, but when he goes down upon the ground itself and lays it out in patches, giving instructions to other people in regard to carrying on the work, he finds that they fail to carry them out. Now, we cannot provide Professor Fernalds on the cranberry patches all over Cape Cod; and, if common men cannot properly manage his application of Paris green, what are we going to do to protect our cranberries, I would like to know?

Professor Fernald. My statement perhaps needs a little amplification. Those were experimental patches. Had the gentlemen to whom I assigned the work taken an apparatus of suitable form to go over their entire bogs, and gone over them in their own way, I do not doubt that they would have destroyed a large percentage of the worms. But that was not exactly the kind of work that I wanted done. That is the way I meant to express it. I think in my insectory I can destroy every insect. If I can show the cranberry grower how he can destroy twenty-five per cent of the insects, it will pay for all that it costs. But I think they can destroy a larger percentage than that. I am not sure that I could go over an entire bog and destroy every insect as I do in the insectory; I feel very sure that I could not. That is a special establishment, built expressly for that kind of work. It is not like field work.

Mr. Ware. You mean that it is impracticable for ordinary growers of cranberries, wanting your superior skill, to manage the work so carefully and effectually as to destroy all the worms, as you would; but what I want to come at is, whether it is not possible for the common farmer, with a little experience, to do the whole business?

Professor Fernald. I think that any farmer of average intelligence, or any cranberry grower, can learn to do the work successfully. Let me say just here that I found that all those cranberry growers on the Cape who were using Paris green were using it in the proportions of what they called a teaspoonful to a pailful of water. I did not know what "a teaspoonful" meant. I took a teaspoon and put it into Paris green, heaped it up and weighed it; then I took up a teaspoonful, shook it a little, so that it would not be so heaping, and weighed that; then I took a teaspoonful, leveled it off, and weighed that; and either of the three was altogether too great a proportion to a pailful of water. They said it would burn the foliage, and for that reason they refused to use it; but it was because they used so large a proportion of the Paris green.

Mr. Hawkes (of Saugus). I have for twenty or thirty years been a cultivator of the cranberry. I know that this year there has been a very full crop of cranberries, and I know from report that Paris green has been extensively used; I therefore infer that it has met with some good degree of success. I have been able to control this fire worm without the use of Paris green. I drown them out. I was one of the first who studied out the history of this insect. I went onto the Cape and compared my observations and experiments with those of others, and found I was right, and that a good many people were completely in error in their statements with regard to this insect. I have quite recently made some experiments, and it will take but a moment to tell you what they were. It was believed at first that the miller, the parent of the grub, did its mischief only in the spring of the year. It is now well known that they come in the fall. I knew that that idea was put forward, and I knew it was an error. I took some half dozen of my vines with insects upon them, and put them under tumblers. It was not possible that those vines could have been in the water. Every one of the insects formed a miller in about two weeks' time. I kept them until they died, and then I took them onto the Cape and showed them.

Now, the way I kill this worm is just simply by flowing. Take the ground in the spring of the year, just after they begin to hatch, when you think there is a pretty good number of them, and put the vines under water from six to twelve or twenty-four hours, and you will destroy the whole of them. The trouble on the Cape is that they have no rivers, and cannot flow their ground. In New Jersey they have rivers, as they have in Middlesex County and other parts of this State where the cranberry is grown, and they are successful in raising it. I have studied this matter on the Cape, in New Jersey, in Middlesex County, and out in Franklin in Norfolk County. I knew that there was a great deal of error in regard to the cultivation of the cranberry and in regard to these insects. Although I have never resorted to Paris green, and have always had an aversion to using it on fruit, yet I think that its use on the Cape has been to some degree successful in checking this insect.

Professor FERNALD. I simply want to say here, in reply to the gentleman, that where the cranberry growers have water, so that they can reflow their bogs at the time that the fire worm is at work, they can kill the insect cheaper by that means than by any other. It is not to that class of men that I can be of assistance, — it is only to those who have no means of reflowing their bogs. And then with regard to the distribution of the fire worm. The egg is laid on the under side of the leaves and remains there all winter, hatches the next spring, and when people set out new vines they very often send and get their vines from bogs which are infested by the insect; and they get them at the season of the year when the eggs are already laid on the leaves, and bring those vines and set them out, so that they bring not only the vines but the eggs of the insect along with them.

Mr. EDSON. Before dismissing this cranberry question, I would like to ask the professor if he has experimented with tobacco?

Professor FERNALD. I have never used tobacco. It has been used to a greater or less extent by the Cape Cod growers, and also by the growers in New Jersey; but I did not suppose I could add anything to the knowledge on that subject. Tobacco is very good, but it is more expensive than Paris green. Why I recommend Paris green is because it costs less, and, so far as danger is concerned, it seems to me almost nothing. Of course it is a poison; you must not eat it.

Mr. Edson. I am acquainted with cranberry growers on the Cape who have not been very successful with Paris green, but tobacco is a very sure remedy. I use about forty barrels on five acres.

Professor Fernald. I think the gentleman would be quite astonished if he could see the replies to the circular letters I sent out, and see what the different men say. No two agree on anything.

Mr. Edson. They go back to tobacco after they have been experimenting with other things, and say that it is a sure remedy if it is put on at the right time. As the professor says, go out early in the spring, and you will find that the insects have drawn two cranberry leaves together and are feeding there; when they eat through the leaves the tobacco will kill them every time. But when you apply it when they are encased between two leaves, it does not reach them. If you can catch them just at the right time, the tobacco is a sure remedy.

Professor Fernald. There is this that I should say in regard to the use of Paris green on any plant. It is desirable to mix it with something to make it adhere to the foliage, and probably nothing is better than glucose. Use a couple of quarts of glucose or a quart even to a barrel of water; then the Paris green will adhere much better, and it will not be so likely to run off or to be washed off by light rains. That I should say would be very desirable in the use of Paris green anywhere.

Mr. Edson. I have been experimenting somewhat this year in using potash in connection with tobacco. I put about a pound of potash to fifty gallons of water, and it seems to work very well.

Professor Fernald. I have not finished my experiments on the cranberry insects, and what I say to-day will only last, perhaps, a few hours. I may change my mind later.

The Chairman. The question this afternoon is the growing of fruit, as well as its enemies. Now, it is well known that we have thousands of acres of land in Massachusetts running up to wild, scrubby growth, that is admirably adapted to the growth of the apple. It is not the valleys and low lands most desirable for farm purposes that are most desirable for orchard purposes; and I think in the State of Maine they have utilized these lands to more profit and in a better way than we have in Massachusetts. We have a representative here to-day from that State, who is conversant with what has been going on there. I will call upon Dr. TWITCHELL to speak upon this question.

Dr. G. M. TWITCHELL (of Fairfield, Me.). Mr. President, Ladies and Gentlemen: It is the truth we are after, and we have got it this afternoon from the paper read by Dr. Fisher, and in the remarks made by Professor Fernald. We have not been doing in the State of Maine as much as you have in this matter of insecticides. I was a little surprised to learn from the professor that the effect upon the foliage was the result of atmospheric conditions rather than the strength of the solution.

Professor FERNALD. I did not expect it to be so; but I found a different result from what I expected from my previous knowledge, just as you have sometimes.

Dr. TWITCHELL. I visited in June the orchard of one of our most successful farmers and orchardists, which covered ten acres. There was one row of Hubbardstons, and every tree was blighted. The solution used was one pound of Paris green to two hundred and fifty gallons of water. This row was right through the centre. A few days afterwards, noticing this effect, he went to another part of his farm, where there were a few trees, and among them one or two Hubbardstons, and there made the same application, with the same result.

QUESTION. What did he use to apply the solution?

Dr. TWITCHELL. I cannot tell you. I think the method of application may be the explanation of the result. Before taking up your question there is another point I want to call your attention to, because I am interested in agriculture down in Maine, and I am trying to do a little, if I can, to help it along. I came in here yesterday afternoon and took a seat in the back part of the hall, and I saw smooth heads all over the audience. I began to single out the young men. I looked in vain for the boys. Now, gentlemen, why didn't some of you stay at home and send the boys here?

Mr. ——. We have them up at the Agricultural College.

Dr. Twitchell. We have not got them yet at our Agricultural College,—I wish we had. That is what I am working for,—trying every way possible to get them there. I like to talk to the boys and young men. As a rule, a man forty-five years old has his mind pretty well made up, and does not like to change.

Fruit growing in the State of Maine is assuming large proportions. In one town this year they set out twelve thousand trees, and that is but the beginning. In that same town they shipped last year I do not know how many thousand barrels of apples, but it must have run up pretty close to a hundred thousand. There is one piece of land of twelve acres which I have been watching for years. The man bought it for seven dollars an acre fifteen years ago, and set apple trees upon it. It slopes down to a pond, and he has taken good care of that orchard. He has taken off of it in the fifteen years fruit enough to pay for the land, the interest on the investment, and for the labor. He sold it last year for three hundred and fifty dollars an acre. Is not that as good an investment as an orange grove in Florida?

In the town of Chesterfield a man who is, I think, the most successful orchardist we have in the State of Maine, bought, fifteen years ago, ninety acres, for which he paid five dollars an acre. He told me last year that about thirty acres of that was in bearing condition, and he said, "I have been offered three hundred dollars an acre for the thirty acres, and I would not sell it for five hundred dollars an acre." Why, he realized from those thirty acres last year a net profit of two thousand dollars on his apples. He got four hundred and fifty dollars out of the skins and cores, one of his neighbors said, and then went to work and burned the seeds and stems to save them. He simply put business into everything he did, just as successful men who are engaged in any other vocation are doing.

Governor Hoard stated yesterday what may become an actual fact before long, when he spoke of creamery butter falling below twenty cents a pound. I tell you you can produce butter and put it on the market for thirteen or fifteen cents a pound, and make as large a percentage of profit as is being made in other lines of work.

We have been endeavoring in our State to encourage our young men to go into some special line of work, that line to be determined by their own taste. John Randolph said he would go half a mile to kick a sheep. He would never have made a success of the business of raising early lambs for the market. And it is just so in orcharding. The man who sets his trees and then leaves them for nature to do the work will make a failure. I think one of the objects of our agricultural schools should be to determine, if possible, what a boy wants to do. When you find a boy working out problems, you may be sure he is not adapted to agriculture, but has a love for mechanics; let him follow his own bent. But when we find a boy who has a love for agriculture, then let us encourage it and stimulate it all that we may.

We are learning something on this question of varieties. A few years ago, if a man was going to buy a hundred trees, he wanted about ninety-nine varieties. He wanted two Baldwin trees, and the rest something else. I asked an old orchardist the other day if he was going to buy a hundred apple trees, what he would buy. "Well," he said, "I would buy eighty Baldwins." "What would be the other twenty?" Said he, "Baldwins." When a man's soil and the climatic conditions are adapted to the growing of Baldwins to perfection, Baldwins he should grow; and when a farm is adapted to growing the Bellflower, Bellflowers should be the product. The men who are making money in the State of Maine out of their orchards are, as a rule, those who are growing single varieties and growing them to perfection. We have a man on the Kennebec River who is marketing from three hundred and fifty to six hundred barrels of Bellflowers annually. By caring for his trees, by putting his brains into his business, he is growing a good crop of apples every year. We have another man who is growing about the same number of barrels of russets; and you gentlemen of Massachusetts are paying from five to eight dollars a barrel for those apples in May, and are glad to get them.

There is so much, it seems to me, involved in this question of varieties and their adaptability to soil, that we have got to go out and study the question, each and every man for himself; because no man can tell his neighbor what varieties will do the best on his land. You can grow pears here to perfection,—you can discount the State of Maine; but when it comes to the Baldwin, I think we can discount you, although we cannot grow any such apples as I saw down-stairs. There are two or three plates of Baldwins that are about three times as large as we grow them. But we have an advantage over you in this respect. If you cut one of those apples you will find that it has already commenced to decay; it is soft under the knife, and the skin peels easily; whereas our Baldwins are tough and hard now, and will not come to maturity and be ready to go to market until the last of January, and from that time until the middle of March or the first of April.

Where do we grow them? We grow them on the hill-side farms on the northern part of Franklin County and in Oxford County, on high, rough, rocky land, — not on land that is easily cultivated. We are not putting our apple trees on our level, fertile fields, where we can raise from a ton and a half to two tons of hay to the acre, and where we grow our corn and grains; we are putting them on the waste land, — have you any of it here, Mr. Secretary? — land that we can buy to-day for from three to five dollars an acre. Riding with the secretary of our Board of Agriculture one day across the town of Greene, we stopped on the top of a hill, and he said: "There's a piece of land I can buy for three dollars an acre; here is a piece of land that will sell for three hundred dollars an acre." What made the difference? Only that a dozen or fifteen years ago upon one side the man had set his apple trees, cared for them, nurtured them, and they were yielding him so good a revenue that he could not afford to sell the land for three hundred dollars an acre.

How to cultivate upon these rocky hill-sides is a question of considerable importance; and I must say, with my natural love for poultry, that I believe that is the place for them. Set the trees among the rocks on a side hill, fence it in, turn the poultry in there, and let them make friends of each other. They will make friends, and each will be helpful to the other. In this way I believe we are going to solve the problem very largely in the near future of successful agriculture. By removing the orchards from the level fields and placing them upon pasture land, cultivating them, fertilizing them and treating them as they ought to be treated, we can materially increase the revenue of the farm, and escape the loss which has resulted in the past where we have taken the best land for the orchard. Now, that, it seems to me, is the line of work for you, gentlemen, in Massachusetts. I do not believe that you can grow every variety of apple upon these levels. I believe that there must be a study of varieties with reference to location, — and it is a pretty broad study. The more I think of it, the less I know about it; but I think, judging by the experience of men who have followed the business of orcharding for years, that that is one of the great problems to be wrought out. Each and every man must be a law unto himself.

Now, my friends, as you go home from this meeting, take this thought with you, and see if you cannot encourage the boys to take up some special line of work, that line to be the one for which they are adapted and have a taste, whether it be for orcharding, for sheep or swine or poultry or cattle,— whatever it may be, let them take that up, and encourage them and help them. If they have a taste for the growing of fruit, help them to get a spraying apparatus, help them to a knowledge of the use of these insecticides, help them to secure a little better foundation for the stock they want to raise, and bind them to the farm by showing them that there is more to be realized there than in any other vocation. Doing this, I believe that next year, or surely within a very few years, the percentage of gray heads in the annual meeting of the Board of Agriculture will be materially reduced.

The CHAIRMAN. The Weather Bureau have expressed a desire to make some different arrangements from those which have existed in the past, with the view of especially benefiting the farmers. They have a representative here this afternoon who desires about fifteen minutes of your time to explain what they wish to do. I have the pleasure of introducing to you Mr. J. WARREN SMITH of Cambridge.

ADDRESS OF MR. J. WARREN SMITH,

ASSISTANT OF THE N. E. METEOROLOGICAL SOCIETY.

Mr. Chairman, Ladies and Gentlemen:—I wish to occupy a few moments in calling your attention to the line of work which the Weather Bureau are taking up in New England, and some of the ways in which the farmers can co-operate with us to extend that work for their own good. But first let us glance at the early history of the Bureau, and its work in the past. We find that by an act of Congress, approved Feb. 9, 1870, the Secretary of War was required to cause meteorological observations to be taken and notice given by signals and the electric telegraph of the approach and force of storms. The summer was spent in organizing, and the actual work began on November 1, with the 7.35 A.M. observation. The results of those observations were charted, but the issue of a weather synopsis and probabilities was not begun until February 19 of the following year, deductions being made as to the probable condition of the weather for the ensuing eight hours.

This work was highly satisfactory, and the next matter to receive consideration by the heads of the department was to display wind signals along the great lakes and the Atlantic and Gulf coasts, warning the marine and other interests of approaching storms. This seemed like a great step at the time to the people, uneducated as they were in the first rudiments of the science; and, if a big storm was predicted, the officials were looked upon as wizards almost, and the man who pretended to forecast the weather even one day in advance was thought by many to be gifted with almost supernatural powers. To illustrate this, I will mention one example. In the early days of the service the establishment of a station in one of the Western towns was followed by unusually bad weather. Storm after storm came up, and much damage was done to crops and other property. After a time fearful glances began to be cast toward the weather office, and soon a meeting was held and resolutions were adopted asking the man to pack up and leave the town, as it was believed that the bad weather was caused by his instruments. A committee of the leading citizens of the town was appointed to interview the observer, and the consequence was that his life was in danger, the feeling against him and particularly against his little instruments was so strong.

We are asked many times to define a storm. I cannot answer that better than to quote Gen. A. W. Greely, the chief signal officer of the army. He says: "A storm is a decided or violent disturbance of the atmosphere, which moves from place to place. This disturbance may or may not be accompanied by precipitation, such as rain or snow; but the area of disturbance must move from point to point, and there must be a decided transfer of air, indicated either by stormy surface winds or by marked changes of pressure. Again, it may be wide-spread, travelling across the country slowly, or narrow and violent, cutting a track a few hundred yards wide and a mile in length. In general, an increase in the velocity of the wind twenty per cent above its mean average velocity indicates that it is a storm wind."

Now, a cyclone is a large storm, from one hundred to a thousand miles in diameter, and moving slowly across the country, generally accompanied in the East by cloudy, rainy weather and a falling temperature, and by clearing weather in the West. A tornado should be distinguished from a cyclone. A tornado is a narrow storm, which cuts a narrow path, but clears everything before it.

Now, these storms as they travel across the country have certain well-defined laws, and it is a knowledge of these laws which enables the forecaster to make any deductions whatever on the probable weather. In this latitude the storms always move from the west toward the east, and the winds always blow towards the storm centre; or, in other words, from an area of cool, fair weather toward an area of warm, rainy weather. It is sometimes very hard to understand that when we have a strong east wind here the storm is not approaching us from over the ocean, but it is coming from the west, and that the wind is blowing towards the storm and not from it.

There are three classes of storms which affect us here in New England, each having a definite path, and each class being accompanied by its own special weather characteristics. The first class approach from over the great lakes, and usually pass down the St. Lawrence Valley. These give us at first easterly winds, which veer to the south and increase slightly in force, generally accompanied with high temperatures and cloudy, rainy weather, and then to the west, with clearing, cooler weather. It is with the southerly winds preceding these storms that we have the excessively hot, muggy days in summer, and the unseasonably high temperatures in winter. Sometimes the storm changes its course when it reaches the eastern lakes, and crosses to the south of New England and then up our coast, with high northerly gales, and, if it be in the winter, heavy snows. It then partakes of the nature of the second class, which come from the south up across New England or across our eastern edge. These are more severe than the former class, but are not so frequent. Sometimes one of these storms will be held back when it is over the Middle States, and then we get heavy and long snow storms. Such a storm was the great blizzard of 1888, when so much damage was done in New York and in some parts of New England. This storm was preceded by mild, spring-like weather, but was followed by one of the most remarkable cold waves on record. Several people were frozen to death in Galveston Bay, and much suffering was caused in the South. In New England the thermometers wandered down to over thirty degrees below zero. One Vermont paper noted a record of over forty degrees below zero; but it added that it could not vouch for the accuracy of that record, as their thermometer became frozen solid at thirty-nine degrees below, and the only way they had to determine the temperature after that was to throw boiling water into the air, and see how far it would fall before it would freeze.

The next class of storms are termed the West India hurricanes. They are very few in number, but when one does sweep in from the open ocean it does much damage along our coast.

New England, as you see, is so situated that we get all of those storms. More than eighty per cent of all the storms that occur anywhere in the United States pass off the coast near New England. During last year one hundred and eight storms passed near enough to New England to affect our weather, some of them lasting only a few hours and others for several days. So you can see why we never have such a thing as settled weather, and why when we go out in the morning we almost need to take two suits of clothes along, or at least our fur cap and ulster and our linen duster and straw hat. We often think of what the old lady said on returning from her first visit to New England. She was asked what she thought of the New England climate. "Climate," said she, "they have nothing but climate there, and have weather only two or three days in the month."

Now, the work of warning the merchant and marine interests of these storms has been well carried out; but it was not long after the establishment of this service before it was found that other interests could be served, and soon all classes began to watch the daily forecasts and warnings. The farmer does not care so much for the large storms as he does for the rapid changes of weather from day to day. Most of the large stations and section centres are necessarily in the large cities, and there has been great difficulty in reaching the isolated farm or village in season to have the warnings of any benefit; but this matter was receiving some attention under the War Department, and in the transfer of the Weather Bureau to the Agricultural Department, which took place last summer, the express purpose of Congress was to especially develop and extend the work in the interest of agriculture.

Without delaying you with an account of the work which the Bureau has done in general since the transfer, I will tell you briefly the work which we are especially trying to extend in New England. The New England Meteorological Society has for several years been doing the State weather service work for all New England. We establish stations, collect data and issue bulletins for the section as a whole. Soon after the transfer we began the work of establishing more stations for the display of weather and temperature signals. Either the morning or evening forecasts were ordered to be telegraphed to any town in New England where the signals would be beneficial, and where flags would be procured and displayed for the benefit of the public, or the signals given by mill whistles. Five flags are used for the display. The flags cost about seven dollars a set, the price varying with the quality of the material. They can be bought of almost any dealer in such things, or can be easily made. What they are made of does not matter, as long as they are the regulation color; but they should not be less than six feet square.

The number of stations that can be maintained under the present appropriation for telegraphing the forecasts has about reached its limit, and we are instructed to cease our efforts to establish new stations, and to turn them toward giving a wider distribution to the forecasts which are already provided for. Those sent to Northampton go to the secretary of the Board of Trade, and he distributes them by telephone to a number of the surrounding towns. The Telephone Exchange at Palmer also sends them out to all their patrons. This work can be extended almost indefinitely by the free use of telephone and telegraph lines; and no corporation or company owning such lines can benefit the community through which they run more than by sending these forecasts from place to place. In some of the Western States the railroads display the signals from their baggage cars, — a thing that might well be done here. The Old Colony road, I believe, did that for a while several years ago, but now they post the forecasts at their stations.

The forecasting was formerly all done at Washington, and covered twenty-four hours from the time of observation. Thus the forecasts which were sent out from Washington to Boston in the morning and from there to the display stations covered until eight A.M. on the following day, and those sent at ten P.M. covered until ten P.M. on the following day. The observers at some of the large stations were allowed to make forecasts for their immediate vicinity, and with the transfer of the Weather Bureau twenty local forecast officials were appointed. New England has two of those forecast officials, I suppose because we have twice as much weather as any other section of the country. Their forecasts are made in the morning for the following day, and cover until midnight. The Washington officials are now sometimes forecasting one day in advance, and after the first day of the year they will do that regularly. Then the display can be made in the afternoon indicating the weather for the next day. That cannot fail to be a benefit to farmers, especially during the summer months. We must not look for too much, however, for when the forecast is made for one day in advance the prediction loses a certain amount of reliability; but just how much of the probable accuracy we are willing to give up for the sake of a longer forecast can only be determined by trial and hearty co-operation.

There are at present in Massachusetts about seventy-five stations, making daily observations of temperature and precipitation. Two of them are regularly established Weather Bureau stations, one at Boston and one at Nantucket; the others are volunteer observers. The stations at Boston and Nantucket have a good many instruments and do a large amount of work, that at Boston especially; but all the others report monthly to our office on blanks furnished by the Society. The eastern part of the State is well represented, but there are several sections in the western part where observers are desired. We wish one for the western part of Hampshire and Hampden counties and the southwestern part of Berkshire County, and in Worcester County near North Dana. We wish some agricultural body or school to get the instruments and put them in the hands of some reliable person to make the observations; or, if that cannot be done, arrangements can be made for loaning a set of thermometers and a rain gauge to reliable parties. The cost of the full set of instruments is about $30. We regret that no compensation can be given for this work, for it is work that should be paid for; but that is entirely out of the question. We desire to secure men whom we can depend upon, men interested in the subject.

There are many who have bought their own instruments and have kept records for several years.

The New England Meteorological Society has been doing a very interesting work during the past summer. We have been collecting and tabulating all the records of mean temperature and precipitation that we can obtain in New England. The oldest record that we have been able to find so far was taken by Prof. John Winthrop, the first Hollis professor of Harvard College, from 1743 to 1775. On that memorable 17th of April in 1775 he took his morning and noon observations, and then he wrote in his record, the original of which I saw and copied the data from, "A fight at Concord puts an end to all observations." We have several of those records, extending back into the beginning of the eighteenth century; but the longest and at the same time the most accurate are those kept by the late Mr. Samuel Rodman at New Bedford, Mass., from 1812 to 1876, and since his death in 1876 by his son, Mr. T. R. Rodman, until the present time. If we had several hundred such records as that scattered over New England, we could tell fairly well our exact climate, and whether it was changing in any way.

Now, right in connection with the weather signal displays which we were talking about a few moments ago come the frost-warning stations. The organization of a system of such stations was begun last fall and will be continued during the winter, to cover the tobacco and cranberry growing sections, and for the benefit of any other industry which is liable to injury by early or late frosts, and which can be kept from injury by a timely warning. The warnings of frost will as a rule be sent twenty-four hours before the frost is expected, and sometimes cold waves may be predicted forty-eight hours before they reach us. The only flag which these frost-warning stations will need to display is the cold-wave flag, which costs about $1.50 by mail; and, as they need to be displayed only when a frost is expected, they will last for years.

We wish to establish a large number of these display stations this winter in the cranberry and tobacco growing sections especially, and prefer that some tobacco grower or cranberry raiser, or some other interested person, should be the displayer, and send from these centres the warnings to all growers in the vicinity by the means best adapted to each locality. One man suggested last fall that the flag be displayed from coaches; another asked, "Why not ring the church bells?" and still another would have the steam cars blow the warning whistle every few miles.

In regard to the crop question, I will say that we wish to enlist a corps of crop correspondents over New England for the coming season. We desire men who are practical farmers, and men who know the condition of the crops around them. There were about seventy such men last summer who reported weekly, on blanks furnished by the Society, the condition of the crops and the way they were affected by the weather. The results of their reports were condensed and telegraphed to Washington every Saturday, and were there combined with other such telegrams from each State, and issued as a crop bulletin. Our own reports were also bulletined at our Cambridge office, and those are sent out to any agricultural body or school or newspaper that will make use of them. This is considered the most important work which the State weather service can do, as giving the farmers a practical knowledge of the condition of the crops throughout the country.

You see from what has been said that, while the Weather Bureau is trying in every way possible to aid the farmer and enlarge this work in his interest, the farmers have got to meet us part way; and as a representative of the Weather Bureau I wish to meet agricultural bodies, granges or individuals, for the purpose of getting acquainted with and learning the needs of the agricultural community; and I assure you that the Weather Bureau is willing to give you what you want and demand in this line as far as possible. If all these bulletins, weather forecasts and frost warnings are of advantage to you, then, by a little effort on the part of a neighborhood or farmers' club or grange, each community can have them; and, if they are not of advantage, then, after giving them a trial, just say so, and any suggestions that you may make will be taken advantage of if possible.

Adjourned to Thursday, at ten o'clock.

THIRD DAY.

The meeting was called to order at 10.30 by Secretary Sessions, who said: —

The topic for this morning is the "Breeding and Feeding of Swine," and it seemed to the committee of arrangements that they needed a chairman who is familiar with the question and has had experience in connection with it. For that reason they have asked Mr. W. W. Rawson to preside this morning, as he is one of the largest breeders of swine in the State.

Mr. Rawson took the chair, and said: —

Gentlemen, the subject to be brought before you this morning is the breeding and feeding of swine. As you well know, the larger portion of the swine that are used here come from the West, and naturally enough your committee would look for a Western man to present the subject. We have with us to-day a gentleman who is one of the largest and most successful breeders of the West. I have the pleasure of introducing to you Mr. Theodore Louis of Wisconsin.

BREEDING AND FEEDING OF SWINE.

BY THEODORE LOUIS OF LOUISVILLE, WISCONSIN.

[Stenographic report by J. M. W. YERRINTON.]

MR. CHAIRMAN AND LADIES AND GENTLEMEN: — When I received the cordial invitation of your secretary to come to your State and deliver a lecture on the breeding and feeding of swine, I hesitated very much about accepting the invitation, because of the great distance of your State from mine, the difference in agricultural methods, the difference in handling animals, the different resources for feed, and the difference in markets. I thought I might not be able to be of any benefit to you by giving you an account of my experience and practice. But, considering the subject at greater length, I said to myself, there can certainly be no difference in breeding and feeding for profit, be it in Massachusetts or be it in the corn belt. The close competition of the day in all farm products calls for the highest intelligence, calls for more knowledge and for greater economy in all our operations. By force of circumstances I became a pioneer in the State of Wisconsin, going there in the year 1848 as a boy, I might say. Reared and brought up in a city in Germany, I left my country as a fugitive. You must know it was somewhat of a change from the work of a silversmith to the study of hogology. By force of circumstances I was located upon a sandy piece of land, and you may ask, "Why, when all the fertile West lay open to you, from the Mississippi to the Rocky Mountains?" But these are the facts, and these facts have been the means of making me a learner, and I stand before you to-day as a learner only. There is no man who will ever become master of the art of agriculture, because we have to grasp and grapple with Nature, and she will never unfold herself unless we pry with knowledge. The painter may delineate upon the canvas the perfect form of an animal, but it is different with the breeder, — he has to content himself with evolution. He has to contend with variations, he has to contend with heredity; and it is ever a study for the breeder to mould and form an animal according to his ideal, and to feed for profit. What is a profitable hog? Let me use the plain Western term "hog." It is one that consumes the greatest amount of food in the shortest time, and gives us the greatest return for the food consumed. And this is the only animal I shall deal with this morning. I have lectured in the State of Minnesota. I was first brought upon the platform because I was a practical man, and you need not expect of me an eloquent lecture; you will only receive practical instruction in the methods by which I conduct my own operations. I am very sorry that I have not here the drawings of my animals and of my stables and fixtures. I received a letter yesterday morning from superintendent Gregg of the Minnesota Farmers' Institute Association, saying that they had been shipped by the American Express Company on the 27th ultimo; but they are not here yet, so I shall have to do without them. I am in the habit of having object lessons with me when I address an audience. I believe that through object lessons we can express our ideas far better than by language.

The breeding of swine must necessarily commence with a good sire. . I do not know what the farmers of Massachusetts are doing, but I can tell you what the farmers of the West are doing. The average farmer of the West — I say the *average* farmer of the West, not the intelligent farmer — gets his sire wherever he can with the least trouble and expense (and I believe you have lots of that kind of men in Massachusetts), and he does not know that such a sire is the dearest animal he ever bought. At the present day, when the breeders have for sale thousands of each of all the different breeds of swine, and when the competition is so great, it costs but little to get a thoroughbred or a pure-bred sire at the head of a herd. Another mistake which is often made is in purchasing a sire in the immediate neighborhood, and the first thing the farmer knows he is in-breeding; while, if he would purchase of a reliable breeder at a distance, who keeps track of the animals that he raises and sells, he could breed intelligently and avoid the danger from in-breeding. We learned from the professor who addressed us the other morning the consequences of in-breeding even in plants; how much more disastrous must be the results of careless in-breeding in animal life? The farmer should leave in-breeding to the professional breeder. My experience has been that the result of in-breeding as a rule is against it. The instances of success are but few, the failures are always the most numerous. The character of the sire is the one thing which is greatly neglected and undervalued by the general farmer. The animal as a rule is turned out with the herd, and is subjected to severe treatment because he is a hog. He is subjected to excessive service, thereby lessening his vigor; and by lessening his vigor we lessen the vigor and power of his progeny.

Before I speak of the character of the sire, I would say that too much stress cannot be laid upon the question of health. At the present day, with the rapid facilities for transportation, what is here to-day is in Chicago to-morrow, and the next day or in a few days it is away off on the Pacific coast. The germ of disease moves as rapidly as the railroad train, and no new animals should be introduced into our herd until they have been subjected to quarantine at home. You may not be troubled with hog cholera or the different diseases of swine. Swine are subject to all the diseases that a human being is, from measles to consumption and cholera. My practice is to confine every animal I purchase at least ten days, away from my herd; so that, if it has the germs of disease, these germs will have time to develop and I will not run the risk of introducing disease into my herd. I have made a specialty for twenty years of swine breeding, and I have had but one hog die with sickness, and he died from typhoid fever. The safest way is to kill a diseased hog outright, and not try to cure it.

My sires are confined in yards eighty feet long and forty feet wide, with tight board fences; each yard with a house seven by eight feet, seven feet high in front and five feet at the rear. They are the cheapest houses either for breeding purposes or for the wintering of hogs. If a man has enough of them, he will find that the herd warms itself. They lie five or six in each of these small stables, and the animal heat will keep them perfectly warm if they are bedded, and the bedding will keep them perfectly clean.

I will not advise as to the breed of the sire. But he should be of great vigor; he should be broad between his eyes; his eyes should be full; he should be short in his neck, let down in his hams, broad through his shoulders, straight on his back. If the sows are rangy, long and loose built, have the boar compact. If the dams are too compact, we should have the reverse in the sire. The market of to-day demands a different hog from what it formerly did. In former years I fattened from sixty to eighty hogs that turned the scale at five hundred and six hundred pounds. When the drover came he would say: "Mr. Louis, I will pay you so much for these hogs; that is more than I have paid anywhere else in the market. I want them for the Boston market, for marine purposes." The Boston buyer is the most liberal man in the Chicago market, and the best competitor. I do not mean to flatter Boston in that respect, but it is true. To-day a two hundred and fifty pound hog is what the market requires, because the lard product is supplanted by an imitation, just the same as butter is by oleomargarine. Besides, the capricious appetite of the masses demands to-day a meat that is marbled, and not either all fat or all lean. So, then, we do not stand in need of the immensely large animal to-day, and we need not seek for an immensely large sire. But here comes another consideration. As a rule, the farmer breeds from young sows, changing his sows every year. He says, "It is cheaper; I cannot afford to keep the old sows." You know that when we are doing this we are acquiring more immature stock from year to year; we are lessening their vitality.

Breeders or feeders are breeding animals regardless of age, and the animal is often subjected to the severe trial of maternal duties at the age of eight or nine months, when she should really be twelve months of age. By the excessive use of the sire the vitality of our feeding stock is lessened. I always have thought that the one-service plan is the safest and best, and the second day of a sow's heat the best time to get her in pig. So much, then, for the use and character of the sire.

The Food of the Sire.

With the Western man corn is cheap and corn is handy. There is no place so handy on a Western farm as the corn crib, and the Western man feeds life and vitality right out of the animal by feeding him corn. The sire should have mostly nitrogenous food, with an allowance of fattening food. The right proportion of food is another important point. I do not believe that any young farmer or any old farmer should be without a work like "Stewart's Feeding Animals," so that he may learn the difference between the feeding value of one article of food and another. There is nothing equal to milk to give the animal muscular strength and growth.

The Dam.

While it is said that the sire is "half the herd," I have always believed that the dam is the biggest part and the most essential part, and she should have the most tender care. Men have smiled at me in institutes when I have talked about "tender care of a hog;" but let us not forget that the animal is a mother at this time, and in that condition she should receive the most humane treatment. It will add to our success. We are not breeding pigs for the sake of doing it, but we are breeding pigs for the purpose of having them to fatten, and it is the number of good pigs that we aim at. Through the good treatment of the dam we achieve success. The man who depends upon good luck in breeding will often fail. I have heard men say, "I had very good luck; I raised so many pigs this year." It was all good luck with him. The next year he says, "I had very bad luck; I did not raise any." I have made an average upon my farm for the last seven years — as the records upon my books will show — of seven, seven and a half and eight pigs to each sow, and I keep twenty sows. I did not depend upon good luck, but upon good management. As a rule, the sows, where there are many hogs kept upon the farm, are turned with the herd. The young sow is fed with the fattening hogs for a certain length of time. I do not approve of such a course. The young sow designed for breeding purposes should be selected after weaning, when she has taken on her best conformation. The average farmer selects the young sows that he intends to keep for breeding purposes when they are about four weeks old, when they have their prettiest form, when they are filled out in every way by the richest food they can ever receive, — the dam's milk. But we should select the animal after it has commenced feeding, so that we may see what artificial food will do for it, and what kind of conformation and growth such food will give it, and we can then judge better of the animal that we are growing. The young sows should be separated from the herd, and should be fed as I have said the sire should be fed. They should have nitrogenous food. It is my custom upon my farm (I do not know what you can do in this line in your State) to feed clover, squash and ruta-bagas, which cheapens the cost of my swine husbandry; and my young sows for breeding are turned to clover, while the rest of the herd are constantly under the pressure of high feeding.

Here comes another point. A sow should not be bred until she is eight months of age. She carries her young one hundred and thirteen days, as a rule, before she farrows. The great mistake is made on most farms that one sow is bred to-day and another in three or four weeks; and when the farrowing season is over the farmer has pigs that were born in March, in April, in May and in June. The intelligent breeder and feeder will see to it that his herd is bred as near together as possible. How shall he do this? After you have once bred your herd closely together, you will find that these animals will all come in heat at the same time. Begin to breed them in the month of October. Take a book and pencil and mark down the dates as they are bred. In our climate we dare not have the pigs come earlier than March or April; at least, the general farmers dare not; those that have stables and suitable arrangements may do so, but still there is great danger in breeding March or February pigs, for the reason that they have no exercise. They do not get out in the fresh air, and generally one-half of them die with the dumps. Then let us intelligently set down the time, and we will find that we can so arrange the matter as to have our sows breed together, or within eight or ten days of each other. Now, then, what have we got on our hands at farrowing time? We must sit up nights, and watch; for the intelligent breeder wants to be right there day and night, and when he knows just the time when the young animals are to appear to life it is no great sacrifice to sit up eight or ten nights. While the animal is pregnant care should be taken that she is not turned with the herd of feeders, for she may be overlaid by the other pigs, and that will often cause abortion. In the West many farmers manage their breeders in an abusive way. They have large straw stacks, and you will often see from one hundred to one hundred and fifty hogs piled up in the different parts of a straw stack, and a man comes with a basket of corn in the morning just before breakfast, when the thermometer is twenty to forty degrees below zero, to feed the hogs. He throws out the corn and calls "Pig! Pig!" and here they come, steaming and fuming and sweating, from a temperature of at least one hundred and twenty degrees. I wonder if those men ever think, if they were turned from their beds out of doors in the same way, what would happen to them. And then they complain that their hogs have pneumonia. There are men who have the pernicious habit of letting their hogs sleep in the manure pile, where the ammonia is constantly arising from the manure, spoiling their breathing organs; and they wonder why it is that the hogs cough and get sick. If you have such pens as I have recommended, you will not have any trouble of this kind. I presume there are men in Massachusetts who need this instruction. I do not mean in this audience, for I generally find that the institutes and the conventions are attended by the best and most intelligent class of farmers, and the man who stands in the greatest need of instruction is never there. But, notwithstanding, I believe that these remarks are in place here. I believe that it is our duty to provide information for the man that needs it, whether he will profit by it or not. That is why these meetings are instituted. Then, I say, feed the young sow intelligently and by herself, and when she has proved a good mother, a good feeder, a good milker, keep her until she is four or five years of age. It is foolishness to turn off each year a good mother, a good feeder, a good milker, and take the chance in selecting another young sow, not knowing if she will make a good mother, a good feeder or a good milker. What do I mean by a good milker? A good milking sow will give nearly as much milk during the time of nursing as a common cow. I think, if my estimates from the weight of the pigs are correct, that I have had sows which would produce thirty pounds of milk in twenty-four hours. This may seem a bold statement; but, if a litter of eight pigs will take on a growth of four pounds during twenty-four hours, and if seven pounds of milk will give us a pound of live growth, it stands to reason that the sow must have given this amount of milk. So there is just as much in the selection of a good milking sow as there is in the selection of a good milking cow. Besides, from an old dam we receive pigs of greater size and better feeders.

Farrowing Time.

Right after farrowing a good many men make another mistake. The first morning after the pigs have appeared to life the man goes in and asks his wife for an extra pan of milk; and he puts all the corn meal that he can into the milk. Then he fills the sow's trough plumb full, because she has a large litter of pigs there. This is not according to nature's teaching. Have you ever observed that, when a sow had strayed away from you when you wanted to put her in a pen as she neared farrowing time, and foraged in the woods for five or six days, she came home with a litter of pigs behind her, and every one of them squealing? What has nature done here? The sow had only a little bit of grass, and she fed the little animals with milk produced from material stored in her own system. The pigs had received only just enough to sustain life and start their growth. They were all alive and healthy. But the man who puts a great bucketful of feed in the trough stimulates the sow's appetite, and the result is quite different. He will most likely within twenty-four hours be complaining to his wife that the old sow is crazy, and that she is trying to eat up every pig there is in the pen; for when the little fellows go near her she rises right up in anger and drives them away. Constipation and fever have set in. The young animals are not able to take care of the abundance of milk that has been produced from the large amount of food, and milk-fever is the result. The best treatment for milk-fever is to kneel right down at her side, take a bucket of hot water, and bathe the udder for at least half an hour; then take some turpentine or coal oil and rub it gently, but beware of getting it on her teats. Give her a loosening food or some salts.

The sow should be fed nothing immediately after farrowing but some warm water and a handful of shorts or meal in it; not corn meal, but bran or shorts. I would increase that feed from day to day until the ninth day, when you will find that the pigs are able to take care of the abundance of milk; and then the sow should have all the food that she will eat up clean, and no more, three times a day. I am an intense feeder and an intense breeder, and I want the animal to consume every ounce of food that it can digest, and no more; and the feeder of swine, as long as he is not feeding in this direction, is losing ground.

Governor Rusk sent a page into Superintendent Morrison's office one morning, with a message that he wanted to see me. When I went into the governor's office he looked me right in the face, as he is accustomed to do, and said, "Well, sir, what are you talking about at the institutes?" Says I, "Hogs, governor." "Hogs," said he; "can't every man raise hogs?" "Yes, sir." "Well," says he, "what kind of instruction are you giving?" Says I, "Governor, in the State of Wisconsin we have, according to the statistics, one million and a half of hogs. One million of those hogs are wintered and sold at the age of eighteen or twenty months; the other half-million are fed from the time they are born until they go to the block at eight or ten months old." "Well, what about it?" "The food of support, governor, of these wintered hogs is at least three pounds a day, without any growth. It costs at least three dollars to sustain the life of each hog during the winter months, or a total to the farmers of the State of Wisconsin of three millions of dollars to simply sustain the life of these hogs." "Go and talk hogs to them," said the governor.

Trough room comes in here, as a very essential point. As a rule, every farmer who is breeding hogs has in his stable a large, deep trough. When the agricultural papers talk about "trough room," they do not mean a great, big, deep trough. I often blame these papers for not saying what they really mean. They mean a trough of sufficient length to give every hog a place, and room to eat in it. This reminds me of a scene I witnessed the other day. Permit me to break off for a moment and describe it. While I was driving through my own county I stopped at a farm where a boy was feeding about one hundred and fifty pigs; shoats, breeding sows and hogs of every kind, all together in one muddy yard. Now, we do not do things at the West any better than you do them here, and not half as well sometimes. Here were all kinds of hogs, large and small together, and the boy was attempting to feed them with swill. The man had good barns, but hogs, you know, ought to be in the mud. That is what is the matter. The boy was attempting to pour a pail of swill into a twenty-foot trough. What kind of a time do you think he had? The hogs were everywhere, and the more he tried to get at the trough the more excited they became. The boy got out of patience, cursed the hogs, and threw the pail, swill and all, among them. By that time a boy on the other side of the rail fence was driving in a team with corn for the morning feed. The hogs had made a failure with the swill, and they saw the team coming, and knew what was in it, and made a rush, tumbling over each other in their haste, the larger and stronger fighting away the smaller and weaker, and all squealing most vigorously. The boy grabbed his shovel and began throwing the corn out into the mud on one side and the other, with the hogs rushing hither and thither after it. That is one method of hog feeding.

Trough room means a trough of sufficient length so that every hog has a place to eat; and in all breeding stables where the breeding sow is fed, a trough made out of plank two by six or two by eight, V-shaped and seven or eight feet long, is quite long enough for the mother and her litter. The trough is laid on the ground, so that the pigs can eat with the dam readily. It is a great achievement for the feeder or breeder to get his pigs to eat with the dam at an early age. I want my pigs to learn to eat with their dam by the time they are three weeks old. In that way I double the growth of the pigs, and avoid an abrupt change of food at weaning time. I leave the pigs with the sow for three months. I think this is a much better plan than to wean them at four or five weeks of age; for in that case the pigs must have a separate stable, and the abrupt change of food will check their growth. They will gain very little for several weeks if weaned at that age; but, if left with the sow, — she being well fed, of course, — they will continue to grow rapidly. When they are three months old they will have learned to eat all sorts of food, and many of them will have weaned themselves, and the separation from the dam will cause no perceptible check in their growth. I think this a very important point in swine growing.

Now, while I am talking hog I wish to say that no man should engage in swine husbandry or in any other husbandry unless he has a liking for it, because a man rarely makes a success in a business for which he has no taste. A man must have a taste and liking for any kind of animal that he wishes to introduce upon his farm, in order to achieve success.

Upon my farm we begin the spring work by sowing from three to four acres of peas. I generally take a piece of fall ploughing, drag it over first, so as to make it rough, before I sow the peas. I use Canada peas, and sow them by hand. Then I take a plough and plough them under five to six inches deep upon my sandy land. Then I sow a half bushel of oats to the acre, and drag the piece over once or twice. By ploughing in the peas to a great depth, I find that in our dry seasons they retain greater moisture and give me a larger crop. I have raised as high as forty bushels to the acre. In my corn field, after I am through dragging and harrowing my corn, — I am in the habit of harrowing my corn until it is eight or nine inches high, —

I plant squashes in every fourth row. I took a walk this morning through your large market here, and saw the immense amount of squashes piled up there. It may seem strange to you that I should raise them for hogs, but it is so. I raise from fourteen to fifteen tons in my corn fields for feeding purposes. I have a rotation of two years, and follow corn with peas and small grain. I sow clover with every bushel of grain. When the pigs are with their dam I confine them to the stables until they are two weeks old, but I let the sow go out every morning to take exercise. Western men very often ask me, "How do you get time to do this? Labor is too high with us." Men very often set a high value upon their time, but they never take account of the time they spend sitting in the grocery store at the village. When all the pigs are three weeks old, so that the older ones cannot steal from the younger ones in nursing, I let them go to pasture. My farm is so arranged that my fields are all accessible to my stable by a lane. There is a brook that runs through the farm, which is lined with blue-grass. I turn my pigs upon the blue-grass first. Blue-grass is not good food for pigs after a certain age; when it becomes hard pigs refuse it, but when it is young they like it, and it gives no abrupt change in feeding. By turning them out early upon this short grass, we do not have to contend with diarrhœa in the pigs. This is not a small matter. The breeders present here know what I am talking about. There are some men who always want to feed something sour to a hog; they have an idea that a hog must have sour food, forgetting all the time that by fermentation we reduce the feeding value of the food, and especially that of milk. Where a great abundance of sour food is fed to a sow, scours is quite likely to set in, and when it once gets started in a herd it generally goes from stable to stable until every sty is affected with it. It is often caused by a sudden change of food. I give a sow a tablespoonful of sulphur in milk or in some sweet swill three days in succession. You will find that you can always allay the disease in that way. Of course a sow should have access to charcoal, ashes and salt.

When my clover is well started, I put a movable fence through the field so as to divide it according to its size, and the sows and pigs are turned upon it, and they are now fed only twice a day in the stable. They are driven to the field the first and second mornings; I do not have to drive them there the third morning, for every little fellow will skip there. They love clover. They stay there all day. If there is no shade on the field, I remove some of those little houses that I have described, and set them up on the field so that the animals can have shade. These houses stand independent of the floors, and the floors are not brought to the pasture. It is abusive to turn a hog into a field for grazing purposes without providing shade for him. They always have access to water. I now commence to soak my shelled corn, and feed it upon the floor of the stables. My floors in the stables are swept clean. Professor Henry used to say that I stole the brooms from my wife to sweep my hog pens. But let me interrupt myself here. There is considerable virtue in this. In the first place, it adds to the health of the hog, and in the second place, when parties from Eau Claire City, from St. Paul or from the large surrounding villages come to my place, they say to me, "Mr. Louis, won't you kill and prepare meats and sell them to us?" Now, I believe that there is an opening for the Massachusetts farmer in a home market in private families, for well-prepared meat. When people know that a hog is kept in clean pens and fed in a cleanly manner, they will buy the meat.

In the morning, as I have said, my sows and their pigs are turned out in the field, and at night they are returned, fed in their regular stables and are confined there through the night. Each sow has her separate stall with her pigs, and each sow knows her stall and each pig knows its sty as well as a cow knows her stanchion. The manure is distributed upon the field during the day, but that made during the night is saved for application to my corn fields. I put my hog manure on my sandy land, and raise one hundred and twenty-five bushels of ears of corn to the acre. Very few farmers in the West ever think of saving hog manure. If a yard is well littered, your stables will be as clean as need be. The hog is one of the most cleanly animals. Still he is called "a dirty hog," but it is dirty man that made him dirty.

I said before, that I allow my pigs to nurse three months. Some of them will wean themselves. That is why I turn my sows to the clover field. Those sows that have not proved good mothers are selected out, and they must go to the shambles; but those that have proved good mothers, I retain until they will breed no longer, — generally until the age of five or six years. Those that are to be retained for breeders remain on the clover, and get two ears of corn a day; and that is all the food they receive until September, when I begin gradually to feed them up for the work of another year. Now, there are men who will say, "I want two litters a year." Truly, man's greed is great, but he forgets all the time that he is hurting himself. I do not calculate to do so. There is another man who will say, "Artificial conditions change nature's course." They do not, a particle. The sow whose pigs are weaned at four weeks of age loses her milking functions as much as a heifer that is dried up after a short period of milking; but, when she suckles her litter until they are three months old, she becomes a more intense milker from year to year. On my farm, where I keep but few cows, I rely largely upon the milk of the dam. When weaning time comes my peas are getting ripe. I have changed my movable fences during the season, and these pigs have had constantly a new, fresh clover bed to go on. Now here comes another change of feed. I commence cutting the peas with a scythe, and feed them over the fence; and I do this myself. When the pigs are used to them, in five or six days, I make a small cut in the fence, and let the little pigs go in and help themselves. This may seem to you a wasteful way of feeding, if you never tried it; but you will find that it is a very economical way. The little fellows will commence at one end of the field and methodically work downwards through it. They will not run through that field of two acres and tread or tear it down, but they will methodically feed it all. I do not think there is a bushel of peas lost, and they eat the foliage greedily. Now, if there is ever a time when pigs will grow, it is the time when they get this nitrogenous food. Then it is that the pig pays the farmer handsomely by preparing itself for the market. When I am about through with the peas, I commence throwing over the sweet corn which I grow in an adjoining field. Before they are through with cleaning off the peas I get them used to the corn. I still feed them their swill nights and mornings in the stable. In the winter time I feed steamed food; for we cannot afford, in our cold climate, to feed cold food. I have seen men pour swill out into a trough, and the next morning take an axe and chop out the stuff they had put in and throw it away. I find there is a difference between your situation and mine, which affects the question of feeding steamed or cooked food to hogs. I am informed that many feeders of swine in this vicinity feed city swill. I have no experience with that sort of food. But under the usual conditions upon the farm it always pays to cook food in the winter for pigs, because it makes the food easier of assimilation and easier of digestion. I use a good deal of charcoal. I burn it myself. I save all my cobs when I shell my corn, and put them in a dry place. I dig a hole five feet deep, a foot in diameter at the bottom and five feet at the top. I have a sheet-iron cover that I riveted together myself, that covers the hole. I set a fire in this hole and commence to fill in the cobs. I draw the fire up by gradually filling in the cobs until the hole is full. It will take about twenty-five bushels of cobs to fill it. When the hole is full I put on the sheet-iron cover and seal it up with dirt air-tight. The next morning I have from twelve to fourteen bushels of the best of charcoal. I take five or six bushels of this cob charcoal (when I used wood charcoal I took about three bushels) and break it with a shovel on the floor, add a bushel of wood ashes, eight quarts of salt and two quarts of slacked lime to it. Mix this thoroughly while it is in a dry state, and then take a pound and a quarter of copperas, dissolve it in a large pail of hot water; take a sprinkler and sprinkle this solution over the mixture which I have described before, and mix it thoroughly, so as not to get the copperas all in one place. Put this mixture in a box and set it where your hogs can have free access to it, and you will be surprised to see how much it adds to the health and to the digestive power of the hogs, and how quickly they get away with it.

Now, in regard to preparing my hogs for market. I believe there is no more profitable way of pig raising than to feed them generously from the time they are born until they go to the block. In the fall of the year I draw in the squashes that I have raised in my corn fields, and commence to steam my food. I find there is a difference in the methods of steaming food. One experiment station will say, in its report, "The food should be thoroughly cooked for an hour or more." Are they not making a mistake? The distillery owner desires to get the greatest amount of sugar possible, in order to obtain the largest product of alcohol. To accomplish this he heats his grain to only one hundred and eighty-two degrees. If you steam food an hour or two hours, you are evaporating a great deal of its food substance into the air. I believe that when food is just cooked we will have the best results. I steam my squash in a separate barrel, and then mix it with the other food. I often read in the papers of pumpkin feeding, but squash feeding will far excel pumpkin feeding in its results upon the growth of hogs.

I thank you for your kind attention. I am ready to answer any questions you may desire to ask.

The CHAIRMAN. Gentlemen, I have a few statistics which I would like to present at this time. The number of swine grown in the State of Massachusetts, according to the last census, is 135,000 per annum, including both old and young. One-half of these were over three months old, the other half were under. The value of these hogs was $1,800,000. The number slaughtered in the State is 1,500,000, — just the number grown in the State of Wisconsin, — valued, when slaughtered, at $20,000,000. The value of those exported from the market of Boston is $7,500,000, — four times the amount that we grow, and one-third of the amount slaughtered here.

I have been very much interested in the remarks of Mr. Louis, and I can heartily coincide with him in nearly every particular. The points on which I should differ are in connection with the matter of feeding. He is obliged to feed grain, but we are obliged to feed swill, which are two entirely different things. That makes a different state of affairs, and of course we have to accommodate ourselves to the difference.

I keep my sows until they are five, six or seven years old, and in that way I always get large litters of pigs, and strong ones. I select my sows for breeding from those which have large litters, and are the best milkers. I have at the present time one hundred and fifty breeding sows. I have about seven hundred small pigs at the present time. It is policy for us to have our breeding time when other folks do not. Other people have their breeding time in March or April, and we want to have ours in December and January, so as to have the pigs ready to sell in the early spring. We do not have very much milk for our pigs, but we buy some skim-milk, and give them all we can get. The man who puts corn meal into the milk I think makes a mistake, especially while feeding breeding sows. He will perhaps lose his sows, and will be very likely to lose all the pigs.

I will call upon a few gentlemen, and, after we have heard from them, I would like to hear from any one in the audience who wishes to say anything on the subject. I will first call upon Professor GOESSMANN.

Professor GOESSMANN. We have been engaged at the State Experiment Station during the last four or five years in raising young pigs for market. The question before us was simply to ascertain at what cost the waste milk from the farm, the skim-milk and milk from the creameries, could be used for that purpose; and therefore our feeding ration was based upon the waste milk from these sources. We have made a practice at the station of keeping a few pigs, one for each cow, which we prepare for the market. We secure our pigs at the earliest day possible, say when they weigh from eighteen to twenty-five pounds. We find that if we begin early with them they get used to our mode of feeding, and we gain more as far as the cost of feeding is concerned; because the cost of feeding for the first fifty pounds differs widely from the cost of feeding for the next fifty. Our animals are weighed once a week before feeding, to ascertain the weekly results of the food supplied. We find that the expense of feeding from the first fifty pounds up to seventy-five pounds live weight costs us about two and a half cents a pound; that, if we take the next fifty pounds, from seventy-five to one hundred and twenty-five or one hundred and thirty, the expense runs up to three and a half and four cents; and that, when we exceed one hundred and seventy-five pounds, we cannot produce a pound of pork for less than five or six cents live weight. So that, when the meat market is as low as we have it in our section, getting probably only five and a half cents for dressed weight, we lose money every day; and it is no economy, with the price of pork in our market, to go beyond from one hundred and seventy-five to one hundred and eighty pounds live weight. If the market is exceptionally high, as it is at times, when we can get six or seven cents per pound, we may make a little money; but of course there is always a reduction in the percentage of gain from the earlier stages of growth.

In regard to the materials fed, I will state, in the first place, that we make three stages of growth. That is, we give for every stage a certain proportion of corn and milk. When we start in with animals weighing twenty pounds we give usually with one quart of skim-milk or creamery milk two ounces of corn meal; when they reach a weight of seventy-five pounds, we give four ounces of corn meal; when they have reached a weight of one hundred and sixty pounds, we give six ounces of corn meal. The reason is this. In the early stage of growth we try to imitate as much as possible the mother's milk in composition. Now, milk as a ration is expressed in the scientific way as one to two; that is, one part of digestible nitrogenous matter against two parts of digestible non-nitrogenous matter (carbohydrates). We increase the carbohydrates, as starch, sugar, etc., as the animals increase in their growth. In the early stages we wish to increase the weight of muscle, and for the perfection of the animal; in the other stages we feed to furnish the fat throughout the entire body, because when an animal has reached its full size it will not increase its muscular weight, but it will increase in weight by the increase of fat throughout the entire body. For this reason, in the later stage of feeding the increased weight comes entirely from the materials which are the so-called "fat producers," as sugar, starch, etc. Corn meal stands first among our articles for that purpose. Whenever the milk is not sufficient for our purposes, we make combinations of grain to meet the same requirements. That is, we have the same proportion, beginning with a highly nitrogenous diet and increasing gradually the carbohydrates as we did in changing the proportions of milk and corn meal. Now, when we have not enough milk and corn meal, or wish to go on with a larger number of animals, we take first gluten meal and wheat bran in equal proportions. In the first stage we take milk with two ounces of corn or corn meal. In the next stage we take corn meal, wheat bran or middlings and gluten meal, in amounts which furnish a ration equivalent to one quart of milk and four ounces of corn meal, — the same relative proportion. And, finally, we take three or four ounces of corn meal, one pound of middlings and one pound of gluten meal. By this means we can supply the amount of food required for a larger number of animals than the milk at our command would afford.

Now, a few words upon food. It seems to me it is most important for farmers to understand and have a true idea of what "food" means. In our standard works the word "food" is used in rather a broad sense, as meaning one single constituent of food, — butter, sugar, starch. Such things are not food in the proper sense of the word, — they are constituents of food. A complete food for the support of animal life requires three distinct groups of substances. That is, each article of food should contain, first, all the mineral constituents, which we chemists sometimes call "ash constituents," because the only thing left behind when we burn them is ashes, which is the phosphoric acid, the potash and the lime of the mineral constituents. Then comes a very important group of substances. They contain as a characteristic the element called nitrogen — with other constituents. We call them "nitrogenous food constituents." The white of the egg, the curd in the milk, are representatives of that class of substances. The next group is a group of substances, of which there is a large number of representatives, and they are the so-called "non-nitrogenous substances," containing the organic constituents of plants, such as starch, sugar, the organic acids, and so on. A large proportion of the weight of plants usually consists of those materials.

Now, these three groups we have to keep always in mind. Each kind of animal at different stages of growth or under different conditions requires of these three groups different proportions. Investigations have been made on this line, to decide, at least approximately, what is the most economical proportion of one and the other in the feed. For instance: when we start out with young stock coming just from the mother's milk, we do not want to make an abrupt break in the nutrition of the animal; we must imitate that milk as nearly as possible with something of similar composition. One single constituent will not answer the purpose; neither the sugar, nor the starch, nor the albumenoids, can support animal life; it must be a combination of these three. That is a matter of fact, and our business is and has been for the last twenty years to find out what proportion of these different constituents gives the best results. So much in regard to the quality and the character of the food.

The next question is economy of food. When we select an article of food, the market price, of course, is the first thing we notice. But what commands the highest price in the market is not always the most costly article to use. Our buying of fodder articles must be with the idea of buying just what we need. If we lack nitrogenous constituents in our home-raised articles, we should buy nothing else but the highly concentrated nitrogenous food in our market. There comes the great advantage of the refuse material of a great many manufacturers; as, for instance, the gluten meal, maize feed, starch feed, etc. All those articles come in most conveniently, and, although costing a high price in comparison with our home-raised articles, they are cheaper articles, for the reason that they leave more behind than any of our home-raised articles, with the exception of clover, and some other leguminous plants. So those refuse materials, such as brewers' grain, mast meal, gluten meal, middlings, bran, in their own way have a peculiar feeding value; and to recognize that is what we have to learn, and from knowing the principles of nutrition we recognize that fact.

The next question is, how we can comply in the most economical way with those requirements, — because it is dollars and cents we are after. Now, in buying our fodder articles in the market we usually look first to general adaptation. That means, in other words, that the article must have a fair reputation as an article adapted to the use for which we require it. Hay has its own value, and so has corn. If we should substitute one of these for the other, it would be a mistake. It would be contrary to the principles of nutrition, and would fail to produce the best results. What we have to learn in regard to those articles is, how we can supplement each in the proper way. Now, take first the milk of cows. What does that article contain? If I need nitrogenous substances, why should I buy corn meal, when I have plenty of similar material at home in form of roots, hay and other articles raised on the farm, which have an abundance of it at less cost? When I go into the market to buy a concentrated fodder article, I inquire, What is that made of? How large a percentage of nitrogenous constituents does it contain? That is the most costly article in agriculture, — the nitrogen. The next consideration is the analysis. Analysis gives us a direct insight into the relative proportion of the constituents in any kind of fodder article we have. Our modes of analysis are based on that, in order to separate these three groups; and in our reports you will find them stated as ash constituents (phosphoric acid, potash, etc.), cellulose (fibre), proteine (nitrogenous matter), fat, and nitrogen-free-extract matter.

Having now ascertained the amount of nitrogen and the cost of it, the question is, what will be left behind. Manure counts for a good deal in our farm economy. There can never be too much manure produced on your farms; and therefore your buying of fodder articles must always be with a view to what is left behind when you get through your operations. A growing animal does not waste anything, it is simply change. The wear and tear is simply discharged, nothing is lost. In a growing animal a certain amount, say from eight to ten per cent, is lost to the manure in growth; and in a milk-producing animal, like a cow or sheep, a certain amount is consumed in the production of milk and wool; but in the end take any two articles, that article which contains the largest amount of nitrogen, phosphoric acid and potash, is the cheapest article if you are in need of nitrogen to supplement your home-made articles.

I wish now to state in a few words simply what our results have been, and the deductions drawn from our results. We begin as early as practicable with a well-regulated system of feeding. We begin, as I have said, when the animals weigh from eighteen to twenty pounds, and feed nitrogenous foods; and, in order to recognize the effect of the food on any particular kind of animal, we have to take a number of individuals and feed them under such conditions that we can determine what each individual has consumed. If we have the whole number in one particular stall, we find that one drives the other out. In other words, the food is very unequally divided. So we put not more than three animals in one stall. In feeding the young pigs during the early stages of growth, we find that they require a somewhat bulky fodder. Now, skim-milk answers that purpose, as it contains only nine per cent of solids, and therefore as long as it enters to considerable extent into your feeding ration it has that effect. If you should continue to feed milk you would not have that effect, because it takes too large an amount of skim-milk to give sufficient food, and therefore it is necessary to change the diet of the animal at certain stages. It is not exactly necessary to say at seventy-five pounds, but at a certain stage, say from sixty to seventy pounds, change the diet. It seems that that rich nitrogenous diet which has been of such good service in a certain stage of growth is not so valuable at a subsequent stage of growth, and that we need to increase the group of carbohydrates, as starch and fat in meal, to increase again the efficiency of the food, because more food is required. We find that it is not good economy in our section to raise pigs for the market to an exceptionally high weight. As I said before, there is nothing to be made on a pig weighing much more than from one hundred and seventy-five to one hundred and eighty pounds with our ordinary market prices.

Finally, it pays well to keep an animal well protected from the inclemency of the season; and it is better economy, as far as the effect of a given amount of food is concerned, to feed during the moderate season with good protection, than to feed during the winter season with very insufficient protection. It requires more food to produce the same amount of live weight in the winter season than in the less severe season, when fair weather favors the animal. It requires more food in the winter season to make up for the inclemency of the weather and the coldness of the atmosphere surrounding them; and it does not pay in the same degree, under identically the same circumstances, to feed during the winter season as well as during the earlier spring and later fall season, unless you have exceptionally good provisions for keeping your stock warm.

The CHAIRMAN. I would like to hear a few words from Mr. Heustis of Belmont, whose father, who has just passed away, was one of the early breeders of Yorkshire swine in this country.

Mr. HEUSTIS. I agree with the lecturer in almost everything he said, except, as Mr. Rawson says, as to his way of feeding. We have to feed with swill chiefly, using some milk. I think there is hardly any profit in a pig after it gets up to two hundred and twenty-five pounds.

Mr. LOUIS. May I ask a question of the chairman? He and the gentleman who last spoke take exceptions to my feeding method, or not really to the method, but to the necessity that causes it. What constitutes your swill feeding?

Mr. RAWSON. The swill collected by the city and sold to us.

Mr. LOUIS. Do you add meal or any solid substance to the swill, or feed it just as you receive it?

Mr. RAWSON. Feed it just as we receive it.

Mr. Louis. I am conducting the swine department of "The Farm, Stock and Home," published in Minneapolis; and the question is very often put to me by feeders from Duluth, Minneapolis and St. Paul, "What ails my hogs?" This year I received the report from one man that he had lost two hundred through feeding city swill. Now, there is a certain danger in feeding city swill or hotel swill, especially if much of the meat of hogs from the West is contained in that swill. The farmer is no more honest than men engaged in other callings; and I have noticed that when a man's hogs are getting diseased he wants to put them on the market if there is any possibility of doing so. I think that the investigation made at Chicago, by direction of Secretary Rusk, will help this matter considerably. But certainly a man runs a great risk in feeding hotel swill. But I will say this: if I were a feeder of hotel swill, I should consider whether I could not make it more profitable by making it more solid with corn meal. Now, the error that a great many feeders fall into is in feeding milk alone, when really, if they put thirty pounds of meal into every hundred pounds of milk, it would double the feeding value of that milk.

Secretary Sessions (to the chairman). Did you ever cook your swill?

The Chairman. I cooked it for quite a while, but it made my hogs so sick I stopped it. I have found out considerable by experience. I commenced feeding swine thirty years ago, and have fed them ever since on city swill.

Mr. Louis. I never fed city swill.

The Chairman. I cannot cook my swill and have my hogs do as well as they will upon raw swill. We lose a hog and do not know what the reason is, and of course we lay it to the city swill. I don't think we lose a larger proportion than Western breeders do. We may lose one out of one hundred. Here is a question from the box: "Is hog cholera prevalent this year in Massachusetts?" I would like to call on Mr. Cheever of the cattle commission to answer that question.

Mr. A. W. Cheever. I can only say that there have been very few calls on the commission to investigate cases of supposed hog cholera the past year in the State. I therefore judge there is comparatively little of it. We do occasionally hear of a case which is said to be hog cholera.

The Chairman. Here is another question from the box: "Do black teeth in young pigs do any harm?" I should say they do. Let them be pulled out. What does Mr. Louis say?

Mr. Louis. My experience with black teeth in pigs is very small, but the answer is correctly given, if they do any harm. My observation is this: that it is not really the black teeth that do harm, but it is the tooth that has grown sidewise and touches either the upper or lower gum, and when the animal eats it cuts the gums, and the trouble is often laid to black teeth. Now, if that is the fact, do as the chairman says, — pull them out; and, if it is a tooth that grows sidewise and cuts the gums, pull that out too.

Question. Will Mr. Louis tell us what breeds or crosses of breeds of hogs are the most profitable in Wisconsin?

Mr. Louis. When the question of breeds comes up, we arrive at a large question; but when we come to crosses of breeds, I do not believe in cross-bred pigs for breeding purposes. We may take a certain cross as a feeder. Say, for instance, take a large breed, like the Poland Chinas or the Chester Whites, and cross them with the Berkshire or any of the smaller breeds, and you will get a better feeder; but here the cross must stop. I do not think we are ever successful in crossing breeds. In the West, the larger the breed the better the hog; because we must now put him on the market at eight or nine months of age, weighing two hundred and fifty pounds, and it takes a large breed of hogs to do this. I think our breeders are making a great mistake. Breeders are moulding and fashioning the hog at the present day for beauty, at the expense of its constitutional strength. We need a hog of considerable size, when its offspring must make the growth that I have stated in so short a time.

The Chairman. I would like now to call upon one of the graduates of the Agricultural College at Amherst, Mr. C. L. Marshall of Lowell.

Mr. Marshall. This is my first opportunity to speak to such a body of men as I see before me. I took a fancy to swine breeding a few years ago while at the Agricultural College, where they have fine animals, which are grown as near to perfection as possible. I saw there some of the Yorkshire breed, and I took home two of them. Since then I have purchased two elsewhere. I found that I could use a few breeding hogs on my place to advantage by raising pork; or, in other words, raising a fancy lot of pigs. So I went to work and built on the south side of the barn a shed about sixty-five feet long and fifteen feet in width. I put in an apparatus for cooking, a place for clean water and a trough for feed. I started in with those four animals, and I now have a herd of thirty-three. My system is somewhat different from that of the other gentlemen who have spoken. It is not exactly what it is in the West, nor exactly swill feeding. As we are market gardeners to some extent, if we have a crop which we cannot turn to advantage, we feed it to the hogs. We give them ruta-bagas, flat turnips, pumpkins, peas and meal, supplemented with skim-milk. At different periods in the growth of the animal we use different materials. For the first part of the growth, that is, from four weeks on to three or four months, considerable of it is milk, supplemented with melons, pumpkins and ruta-bagas; and, as they increase in age, we change it to a somewhat more concentrated food. We now have seven ready for the butcher. We have been feeding them since spring, and they will dress two hundred pounds each. I think that a great deal depends upon the selection of the animal, and the best time for making the selection is when they are six or eight weeks old. Then skim-milk, oats and barley make an excellent food. I should prefer it to any other.

Mr. Rawson. I find it necessary to wean my pigs when they are about five or six weeks old. That is because the young pigs then begin to eat swill, and if they eat swill and nurse at the same time it does not always agree with them, and therefore I like to wean them when they are about that age; but if you feed them upon shorts and milk you can keep them with the sow much longer.

Question. What kind of squash does Mr. Louis grow?

Mr. Louis. I received some seed from the department at Washington of a variety called the "Boston Favorite." They are a yellow squash, and grow very large. They will grow to weigh forty or fifty pounds. They are not a good family squash; for our table we use a different squash. But we find that they give us good satisfaction in pig feeding. In fact, I am not very particular what kind of squash I have for my hog feeding, if I can get enough of them and if they contain enough sugar. I like those that are very meaty. The squash to which I have referred is a very meaty squash.

The Chairman. That is what we call the old-fashioned marrow here.

Mr. Louis. Maybe it is.

Question. Do you think there can be any profit in making pork when corn is eighty cents a bushel and pork six cents a pound?

Mr. Louis. That would largely depend upon whether you feed the hog on corn alone. If you had such a system of feeding as I have on my farm, — if you had considerable clover and other feed mixed with it, — then you might possibly do it. Feeding my hogs in that way, I get them up to two hundred and fifty pounds at comparatively little cost.

Mr. ——. I am obliged to use corn or corn meal largely, and it seems to me that from the time they are cut off from their milk until I am obliged to sell them I lose money on them every hour. The great trouble is that they are ready for the market at a time when there is so much poultry that it is very difficult to sell them, so that I keep them oftentimes some weeks longer than I wish to. Everybody is crowding his hogs upon the market, and the butchers will only offer perhaps five or five and a half cents a pound.

Mr. Louis. Very true; but, if you take the difference between the cost of feeding them if you sell them at two hundred pounds and if you sell them at four hundred pounds, you will find that you had better sell them when they reach the smaller weight.

Mr. ——. My experience is that, when corn is as high as it is now, and pork as low, it is a loss to feed hogs.

Mr. Louis. I have found in all my experience that the men who are complaining of the low price of pork are the men who generally go into hogs when they are high, and they have not fairly got into hogs when the market drops again. You will see, in consequence of these two years of low prices, that pork will rise next year or the year after to a high figure; and then these men who are weary and tired of raising pork will not have any on hand when it goes up.

Dr. Twitchell. Will you describe your breeding pens?

Mr. Louis. My hog houses are seven by eleven. I wish to say this about hog houses, as it seems there is greater interest here in swine than I had any idea. I think a double hog house, which is the way they are generally built here, is a nuisance. At least, it would be in the West. Our prevailing west winds and north winds in the winter season make them very cold on one side. It is a matter of necessity that the hog house should be double, unless the side runs to the north or to the west. My floors in the hog house are cemented. That is, my walls are a foot high, and I put gravel inside the wall and fill it up. I lay a ten-inch plank on the wall, and toe-nail my studding to it. Lumber with us costs only eight or ten dollars a thousand, so the cost of lumber would make a very great difference with you. I lay my plank upon the wall, and then fill gravel inside the wall and pound it down within an inch of the level of the plank sills. Then I lay my joist in this gravel, level with the sill again, fill this space with cement, and put an inch board on the cement while it is green. This will make you a floor that will last a great many years. Besides this, you will never have any trouble with rats, which are a great nuisance in a hog house; and, if any disease should ever occur in your herd, it will never penetrate beneath your floors.

Question. I would like to ask whether clover winter kills in Wisconsin. We cannot be sure of it here.

Mr. Louis. Yes, sir. Once in a while we will have a winter-killed field. We had a field last winter that winter-killed. We had no snow. But, as a rule, we get our clover through all right.

Mr. Elbridge Cushman (of Lakeville). I have been very much interested and pleased with the lecture this morning, as it conforms so universally to my experience in a small way in keeping swine. I have been accustomed for many years to keep a small number of breeding sows, and sell the pigs, fattening those that I could not sell, and disposing of them at about the weight of two hundred pounds.

I want to say one word in regard to feeding. I too frequently see hogs wallowing in narrow pens in filth up to their sides. I never believed that anybody could succeed in making any money by keeping hogs in that way. It has been said here this morning that the hogs of some of the speakers were fed largely on swill. Most of us know that a very small proportion of the farmers of the Commonwealth are so fortunate as our chairman in having the great city of Boston to feed his herd of swine. You and I, brother farmers, have to feed our swine from the products of our own farms; and what I want to say here is that I have always thought that the very cheapest food for swine, as well as for dairy cows, is grass. Turn your hogs to grass just as soon as you possibly can, and give them grass as a rule until they reach the weight of a hundred pounds. My hogs this last summer have been in a lot of between four and five acres adjoining my orchard, and early in the season I took down the fence and let my breeding swine go into the orchard, and for quite a number of weeks they got their entire living there, with a very little water carried to them every day, and they were in a better condition, really, than I would like to have them for breeding purposes.

Now, one word in regard to breeds. I have found it for my interest to buy sows of the larger breeds. While I have bought my sire, a pure-bred Yorkshire, of our chairman, I do not care to buy my sows of him. I want to get them from another source, because I want a larger sow. I have been successful in getting litters of thirteen, fourteen and fifteen to a sow. For the last year and a half I have not succeeded in keeping a pig until it got up to a hundred pounds in weight. My rule has been, when a pig would weigh from fifty to a hundred pounds live weight, to ask the same as the market price for dead weight. A day or two ago I sold the last ones that I had, that averaged between fifty and sixty pounds, for six cents a pound live weight. You may think that I had better have kept them; but for my own interest I thought I had better dispose of them at that price. If we have good, clean, handsome pigs, they will sell themselves, and there is no trouble usually in the health of the hogs. I want to say right here that, after careful observation for years in breeding swine in this way, I think they are as profitable as any class of farm stock that I keep. But it has been suggested here this morning that it is no use for everybody to try to breed swine. Well, gentlemen, unless you are willing to jump out of bed any time in the winter, grab a lantern and go to your pig pen, and, if you find there is a sow in labor, stay there with her until morning, — unless you are willing to do it, and know how to do it, it is no use for you to try to breed hogs. I employed for nine years on my farm one of the best men to take care of dairy stock that I ever had, and he tried year after year to keep a pig and raise his own pork, and he utterly failed every time, until finally I begged that man never to try to raise another pound of pork. Every time he went to feed his pig he had to have a fight with it. To-day I have a man on my farm that I would not like to trust to feed my swine; and to-night when I return I shall be surprised if I do not find more feed in the trough than they have eaten for the last twenty-four hours. It is not in him to feed a pig.

I say you must abandon the idea that you can keep pigs any how and any way, in dirty, filthy pens, and make a profit; but, if you keep them as I have suggested, putting them upon the market when the market demands them, I know of no more profitable class of farm stock than swine, and if we have sympathy with them and enjoy keeping them, it is a good business.

Mr. Ware. I would like to ask Mr. Louis whether the breeding sows turned into his clover do not root it up, or does he ring them?

Mr. Louis. Yes, sir; there is trouble in that direction. I am very prompt to put rings in their noses.

Adjourned to two o'clock.

Afternoon Session.

The meeting was called to order at 2.15 by Secretary Sessions, who said: —

The committee of arrangements have appointed as chairman for this afternoon a gentleman who is specially interested in the subject we have to discuss, Mr. Francis H. Appleton of Peabody.

Mr. Appleton. Gentlemen, this is a subject which is undoubtedly of great interest to you, and is undoubtedly of much interest to the State at large, from the fact that quite a number of the executive officers of this State who have been elected by you have seen fit to incorporate in their inaugural addresses a reference to the subject, hoping that the country roads of the State might be improved, and that some system might be adopted which would advance that improvement. To-day we are very fortunate in having with us a gentleman who has given the subject a great deal of attention, and it gives me great pleasure to introduce to you Mr. Olcott of Connecticut, who is an expert in this department.

ROAD MAKING AND MAINTENANCE.—THE LATTER WROUGHT INTO THE TEXTURE AND STRUCTURE OF THE ROAD.

A RETURN TO FIRST PRINCIPLES.

BY JAMES BRADFORD OLCOTT, SOUTH MANCHESTER, CONN.

The truths of stone-road structure are as old as the hills. Every road that runs over a knoll of good gravel reveals to the industrial student the highway science of pulverized rock in *un*equal sizes, compacted and fixed solid in their own matrices. These naturally perfect bits of road are never wet or loose, because their granulated substance cannot be softened by water, and broken by frost; they are rarely dry because of capillary moisture; they are always smooth, because the pebbles composing them are hard enough to endure friction, and because there are no stones large enough to jolt the wheels of vehicles.

Hence gravel knolls in the road are full of instruction for the artificial road maker. His endeavor will be to manufacture a gravel and a bed for it as good or better than the best natural products. A coarse gravel is wanted, that will knit and set in a clean masonic structure, nearly or quite as solid as the original rock, and in the form of a floor convenient for travel. This floor will be a roof, also, repelling the water of rains and snows from its dry earthen foundations. All theories, doctrines, systems and principles of stone-road making that are good for anything originated among observed facts in nature, like the road texture of the gravel knolls above quoted, and may be brought back to them for correction and strengthening.

That isolated stones will settle in the earth by their own superior gravity, and without the aid of Darwin's angleworms, was known to man as long ago as when the cities he hated were levelled so that not one stone remained upon another. Gardening and farming tribes in the earliest ages must have seen that scattering stones would sink in the soil by their own weight, and prehistoric log-rollers — the first broad cart wheels — were doubtless used by the ancients to settle the pebbles rooted up by the plough.

This leads us to the idea that dislocated stones, wandering from the road-bed, are so much lost to the body and coherence of the fabric; and that any intrusion of earth or clay in the substance of a stone-road is a divisor, an entering wedge of decayed material, mud-mortar, scamped masonwork, an element of disintegration, and one of the earliest symptoms of the total destruction of a highway.

Our roads are wretched, and, while road literature is of the same muddy structure and texture, our endeavors to amend practice must be largely experimental, and, till we get our heads clear, should be entered upon with extreme caution. It will be far cheaper to study the blunders already before us than to make a new spread of our own in search of experience.

In union there is strength. This should be the stone-road maker's motto and law. He must see to this in preparing a place for his road materials. Let it be a drained concave bed in the earth he has to make a road over. Where the bottom is more loamy than sand or gravel, there may be occasion for artificial drainage.

The road principles hinted at in the accompanying engraving are too various to be conveyed on paper. The art of road making, like the working of metals, comes only by thought, practice, experience and labor. Grass, earths, sand, gravels and rocks are all manageable by methods in strict accord with their great variety of natures. Skill results from the personal handling of road materials. The children of a generation that has built fifteen hundred thousand miles of iron and steel roads *on wooden foundations*, should enter the field of common road making modestly and with caution. The writer has no *local* road advice to offer to places and persons he has not seen and examined. His words are to be applied at the reader's risks and charges.

The turf-gutters in the picture will shed water from road foundations as mud will not. That concave road-bed might need to vary in depth from ten to forty inches, or more, according to local conditions. Whoever is not familiar with the study of roads may need to turn to the engraving in the progress of this essay, or refer to the accompanying Appendix, with illustrations, and should give much time also to the structure of old and new highway work beneath the surface.

The road-bed of the picture may be of any width, with or without foot-paths. In the worst situations the triple drainage will be necessary; in others, one or two lines of pipe will do; in still others, natural drainage may be trusted. Truth is unfit for us till it is fitted to our circumstances.

In villages, city suburbs and the open country, wherever the friction of travel is not too severe, gutters of fine grass over gravel will utilize what else would be dust or mud, in producing merchantable turf. The flattened ellipse is the strongest and most economic form of stone in the road-bed. Well filled, these road arches never "kick," and the stone of them do not sink or break loose from one another. The bottom of clean, coarse sand, or fine, clean gravel, of a dry, loose quality, that would be entirely unfit for the surface of a road, is, when puddled solid in the clay bed, admirably fit to hold a stone-road up, while preventing the clay of the subsoil from rising.

Gillespie* says of sand: "This material, when it fills an excavation, possesses the valuable properties of incompressibility, and of assuming a new position of equilibrium and stability when any portion of it is disturbed. To secure these qualities in their highest degree, the sand should be very carefully freed from the least admixture of earth or clay, and the largest grains should not exceed one-sixth of an inch in diameter, nor the smallest be less than one-twenty-fourth of an inch."

The above description answers for coarse, sharp, masonic sand, suitable for heavy stone-work; every expert mortar-man or farmer is a judge of it. There are banks of fine gravel, equally good for the foundation of broken-stone roads. It is not too much to say that, for adding depth and security to the best road work, sands and gravels devoid of all suspicion of loam or clay-producing material are fully equal to any possible quality of stone, when bedded below all chance of wheel-friction. This value of sand and gravel for the best roads over clay, brings them well within the line of profitable railway commodities.

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* "Roads and Railroads," New York, 1858

The reason why cobble-stone and granite-block pavements so frequently settle out of shape and make a rough, jolting road, is because the sand used is dirty, rarely or never compacted by trampling or puddling, and in cities is often dug deeply in holes and ditches for pipe repairs, etc., just before and while the pavement is being laid or relaid. In such cases cement finds opportunities that would not appear if the sand were faithfully and intelligently treated.

Beginners in road making may need to be told that fresh deposits of sand shrink in settlement, and how the shrinkage can be hastened by rains, artificial waterings and the trampling of horses and cart wheels in a concave road-bed. A boy and one horse will do the work of many paving rammers. The firmness of sand under water is well shown by the fine wheeling on some sandy beaches while the tide is out.

Where neither sand, gravel or coal ashes is to be had, and a solid road of broken stone is desired upon a clay subsoil, the drainage of the clay must be thorough, and the most scrupulous pains taken to have the stone fine enough to fill its own crevices perfectly, and resist the ingress of the insinuating clay. Not only the bottom of the stone-road body, but the whole substance and texture of the crushed-stone structure, must be impermeable to clay or mud in any form, and the water of rains also, that might else wash surface filth and clay silt among the broken stone. The permanence of the road depends on absolute faithfulness in these particulars. In this light the value of the bottom filling of sand will be seen, because is is so much easier than stone to handle, and in its place even more effective.

It is impossible to pass, in this connection, the modern doctrine of painstaking "porosity" in stone-road structure, without condemning it as a ruinous fallacy, chargeable with ninety-nine one-hundredths of our costly failures in producing either durable or smooth roads of broken stone. It puts a weakness in theory just where the carelessness of workmen is most liable to be fatal to the integrity of the road.

Quoting or condensing from Penfold, a contemporary of M'Adam, Gillespie well describes the behavior of broken stone in "even sizes," with open joints, as we have been laying them for years in sight of everybody: —

"If a thick coat be laid on at once, there is a very great destruction of the material before it becomes consolidated, if it ever does so. The stones will not allow one another to be quiet, but are continually elbowing each other and driving their neighbors to the right and to the left. This constant motion rapidly wears off the angular points and reduces the stone to a spherical shape, which, in conjunction with the amount of mud and powder produced, destroys the possibility of any firm aggregation, and the road never attains its proper condition of hardness."

The above scrap was published in London in 1835, but it will pass for recent American road history, and can be read in the unsound structure of our broken-stone roads almost anywhere.

European malpractices, discovered at home, are played on American cities and villages. It is not the road-mender alone who needs to be taught, but our whole people. The road-mender has grand chances to learn from his own and his fellow's blunders; but who is teaching our people? Boards of education have robbed us of the picture in the spelling-book showing the superior "virtue in stones," but boards of health ought to save us from street-filth leaching through "porous" roads into our cellars.

Stone road work that is "porous," while at the same time "unyielding" and "solid," seems to have been first advocated in the vicinity of Boston, on whose dry bottoms fabrics of that peculiar description may have the air and water arrangements crushed and ground out of them in time by dint of heavy travel; and this without other loss than by bruising the heels of taxpayers over rough surfaces, and costs for maintenance.

Many other cities — used to cubic yards of ventilated stone — admit the honeycomb impeachment. They tried the hollow structure because it was said to be "scientific." It made a show of rough road quickly, and was much less trouble than mixing the different sizes of stone together, for really solid work, after they had been assorted according to municipal orders at the crusher.

But no thoughtful city with a clay subsoil, considering the money it has sunk in stone gone wandering amidst the mud of its rough and dirty thoroughfares, can regard that porous doctrine with anything but disgust. It won't hold water. Hadn't we better go into asphalt? Is it worth while to try playing that porous swindle on the country at this late day, even in the compound form of "Telford-Macadam?"

Telford was a shepherd's son, who learned the stonemason's trade in his youth, and became a great engineer. He believed in setting large cobble stones, points upwards, to stay the middle of his track. That gave employ to the paving fraternity, and strengthened his gangs with men who loved stone. This was good, but where is the evidence that he contrived hungry open-work in the bottom of Holyhead Pike to swallow all his surface finish? Nobody who studies the slow geologics of the holes in stone-roads to-day, can believe the eminent engineer gave his name to a hollowness that every common laborer of that time would detect. He must have filled that with sand or gravel.

The magnitude of M'Adam's job, with thirty thousand miles of abominable stone roads, accumulated by centuries of mismanagement, and waiting his revolutionary hand, compelled him to say to the committee of Parliament that he was not lifting but four inches of their horrid old highways, and breaking the stones of them over again. That was as deep as he dared let government know he was thinking at that time. The dirty bottoms of stone he left underneath might be construed into evidence that he approved that way of building a road, if he had not expressly denied it. Yet that is all the foundation we have for coupling the names of Telford and M'Adam together in a compound "system." He saw the cover for defective work in the use of large stones in the road-bed, and in theory and practice would have none of them. Break the stone into homogeneous rock gravel, and allow no earthy admixtures, is the key-note of his testimony.

In a time of general depression, with road management cut into small "trusts," administered by the inefficient and dishonest, he gave starving cottagers work at their own doors, and for the first time in English history made easy communication possible throughout the kingdom. That small middle-men, contractors, local ignobles, and even engineers, whose trade he was giving back to the people, were jealous of and misrepresented such a figure in road history as that, cannot be doubted.

As for a "system," M'Adam had none. He looked at his work, and did the best he could for it in each case. His son James, — who afterwards accepted the baronetcy the father refused, — when asked by Parliament if he worked under his father's "system," preferred to say, "on my father's *principles* for making roads." M'Adam's road-principles were new road-brooms of fresh ideas for sweeping every corner of the Commonwealth, displacing the venal agents of an ignorant government. His youth was spent in America, and he seems to have carried the best of our revolution home with him.

M'Adam's own statement was this: —

"In every road I have been obliged to alter the management, according to the situation and sometimes according to the finances."

He tried to break existing systems, and to induce road-men and governments to look at things as they were, and do whatever was necessary. It was the printer's title to his collected pamphlets that gave him the repute of a "system."

For the much-mooted question of the size of road-stone he had this settlement, as applicable now as then: —

"*If you made the road of all six-ounce stone it would be a rough road, but it is impossible but that the greater part of the stone must be under that size.*"

Six-ounce or egg-sized stone were as large as he wanted the largest stones to be in the top four inches of the roads he mended. In breaking all to that weight, or below, there would certainly be plenty of stone chips. No thought of a porous texture could have been in his mind. That any one could seriously entertain such an absurdity as intentional "porosity" in a "solid" road of broken stone, would have been incredible to him. His gangs of men, women and children, — whole families sometimes, — wrought by the side of the way, lifting two or three yards of the old road out of the mud at a time, breaking stone at ten pence per ton by measurement, and immediately replacing them handsomely on the highway. The shining contrast between the old and new work was a powerful argument in its favor, and the welcome idea spread like wildfire.

He reduced the expenses of the road-trusts he consolidated; but, as his figures showed three-fourths hand-labor, instead of three-fourths team-work, as formerly, we can see how the old road barnacles must have hated him for teaching the people.

The most of M'Adam's sayings we see quoted now-a-days are used in such a way as to make nonsense of them. His injunction not to break stone on the road referred to his wholesale treatment of rough road-work, which could not be done in the muck of old road-beds, without soiling the fresh fractures of his new-made material. But there are very many times when the hammering of cruel projections from the surface of our stone-roads would relieve men and animals from torment at a very cheap rate, — if M'Adam had not forbidden it. Considerable roughness is required in our practice to overcome the dread of "resurfacing," and make the people cry out for another coat of rough stone, as well as to assist in producing what is called a "bond" for it.

M'Adam despised any form of dirt among his metals: —

"*Nothing is to be laid on the clean stone under the pretence of binding.*"

With his boulders broken fine enough to fill their own interstices, there was no need of that "pretence."

He did direct that broken stone, when applied to a road, must be carefully "*scattered over the surface, one shovelful following another, and spreading over a considerable space.*" This was very sensible in M'Adam's roadside practice, where he was liable to find all sorts of stones — some softer than others — gathered from the land and dumped into the old roads he was reworking, so that his broken rocks needed spreading widely to mix all sorts together. He feared that a shovelful of very hard or very soft rock, by wearing unequally, might make a lump or a hole in his road. But the produce of our quarries is or may be so uniform in quality that the obsolete precaution has no reason in it for us; yet we see the slow-spreading motion surviving in our road-craft, while vital matters are forgotten.

For once in the world there was a road-mender who actually made the wheeling better. People drove out of their way to see it done, and were happy to assist in testing and trampling the new work solid. While every neighborhood wrought before its own doors and was making its own roads clean and sound, fit for any woman or child to walk upon in muddy weather, we may be sure there was generous rivalry between the different sections, and many merry challenges and blithesome rallyings as the good work went on.

Precisely when the salt of M'Adam's example was lost, and greed and craft got possession of the roads again, appears in no history. But a change is noted in one of Mary Russell Mitford's English sketches. She describes it as a "misfortune" that "has befallen us underfoot. . . . For the last six months some part or other of the highway has been impassable for any feet except such as are shod by the blacksmith; and even the four-footed people who wear iron shoes make wry faces — poor things! — at those stones, enemies to man and beast. . . . I never wish to see a road-mender again."

We only need to be reminded here how the rough road-menders, in every form, from pig-pen sods, tracks of excruciating rocks, spruce and granite blocks and the smoke of coal-tar torment, have run riot over this American land, till the people are driven again to learn to mend their own roads.

Never reprinted in this country, the scarce writings* of M'Adam are still our best resource for the genuine science of broken-stone roads. With nothing whatever to sell, he could afford to tell the truth, as follows: —

"Having secured the soil from under-water, the road-maker is next to secure it from rain-water, by a solid road made of clean dry stone or flint, so selected, prepared and laid, as to be perfectly impervious to water; and this cannot be effected unless the greatest care be taken that no earth, clay, chalk or other matter that will hold or conduct water, be mixed with the broken stone, which must be so prepared and laid as to unite with its own angles into a firm, compact, impenetrable body."

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* Thanks to Prof. W. H. Brewer, of Sheffield Scientific School, for the use of one of them.

Find room for a "porous" spot in that, if you can.

In the accounts of the road-trusts he overhauled, M'Adam saw well enough how figures could be made to lie, and so preferred to avoid giving mathematical color to suspicion in his writings; yet his meaning is plain. He had unbounded faith in wrought stone over dry earth. But who has seen his ideas exemplified in any quarter of the world? Let him repeat: —

"*The thickness of such* [stone] *road is immaterial as to its strength for carrying weight; this object is already obtained by providing a dry surface over which the* [stone] *road is to be placed as a covering or roof, to preserve it in that state; experience having shown that, if water passes through a road and fills the native soil, the* [stone] *road, whatever may be its thickness, loses its support and goes to pieces.*"

"Encyclopedia Britannica," while admitting "road-scrapings" among "binding material," declares that "*The name M'Adam often characterizes roads on which all his precepts are disregarded.*"

That broken-stone road may be a "roof," shedding water from its own foundations, as well as a "smooth floor," affording pleasant wheeling at all seasons, were among M'Adam's principles and practices, and are what we want to-day; but we can reach no such result as that in the way of porous, crumbling bottom-work, a ventilated mid-structure, and the chip-stone which should fill its crevices reserved for top-dressing.

Our modern way of screening and assorting road metals — so abundantly illustrated in rock-crusher circulars — has left our roads open at the top to water and filth, open at the bottom to clay, and open everywhere to the question whether the taxpayers are being blundered or cheated out of their money.

M'Adam complained bitterly in his time of the misappropriation of road funds. He found those in authority too ignorant to govern properly; and men are saying now that our streets furnish fields for the expert politician rather than for the expert road-maker. The records of boodle governments could never be so black without engineering sharpers to figure for them. And the worst of our predicament is, we are often led to hound the honest man to death, while we let malefactors go free. The only remedy is for the whole people to study the highway to the bottom, so that bogus operators may be restrained or detected on the spot. The art of road making in common schools would make a good foundation for political economy in high schools.

The amateur road student will not understand the forces that are moving us, without considering the rise of road machinery, and a keen study of its trade circulars. While metropolitan cities are discovering — by the shrewd observations of some common laborer — that the broad tread of the weightiest steam roller will not pop toads in a sixteen-inch mass of "even-sized stone," — half cubic air, — it dawns upon the minds of sharp road machinists that the stones must be applied in layers so thin that they can be rolled separately or crushed flat, and partly in powder, for which the steam roller is said to be indispensable.

At the same time, the maiden village (with a lot of suspicious farmers in her composition), beginning to think of being a city some day, requires a different treatment to make trade good. There a single thin layer of broken stone, in the form of "an arch over the clay," is recommended. This looks "scientific," makes a better road for a little while, — till the clay begins to break up, — and "pays well" for the beginners of the "resurfacing" business. But every one should remember these are no fair tests of the principles of M'Adam, or of the far older truths in geologic deposits, always open to the study of peasant and scholar.

Without detracting at all from the just deserts of enterprising road machinists, it is evident now, as in M'Adam's time, that we ought to give hand labor a better chance. We must make better tools, furnish more thorough training, continuous employment and higher wages for precision and skill, that will attract expert hands and acute minds into the stone-road business. Men are wanted who can appreciate M'Adam's principles, and apply them to the highway. It is hard telling whether our roads suffer most from ignorant leaders and labor, or inattention of the public.

To read the claims of our steam-roller brethren for their machines, makes one wonder how either Telford or M'Adam ever made a decent bit of road before steam traction was invented. And nothing needs to be more fully explained at the present time, to raise the hopes of our people, than the fact that with dump carts running on broad tires, having ten or fifteen hundred-weight on each wheel, the stone itself can be made to roll its own road solid without any additional expense whatever. Wheelmen should see to it that factories for broad cart wheels are established in every State right away, or arrangements made for importing them free of duty.

The pamphlet circular of the Aveling & Porter steam roller, in its certificate of award from the international jury of our Centennial Exhibition, endorses the sterling principles of the broad-tired cart wheel in these terms: —

> "The principle of dividing the rolling surfaces AS MUCH AS POSSIBLE is of GREAT IMPORTANCE IN ROAD MAKING, since the weight thus distributed penetrates, so to speak, beneath the surface, finds out the weak spots, and causes an even, uniform condition underneath, while the inequalities of the surface can be overcome by the addition of metals in the holes."

It is a pleasure to recognize this brilliant common sense among the higher engineering circles of Japan, Spain, Great Britain, the Argentine Republic and the United States, represented on the international jury.

In an immense country like ours, where millions of miles of quagmire roads and streets shine with thick and slab mud in the sun of every open winter; where our skeleton of a population is scattered over vast surfaces by railway, it makes the owner of valuable stone-crusher patents (capable of digesting a ton and a half of rocks per minute) feel rich, considering the enormous road fields requiring his kind of top-dressing. But he ought to be very careful about the pictures he circulates to illustrate his business. No people can make woful blunders and continue to pay. A narrow-tired prairie wagon backed up to his broken-stone elevator, with the screened coarse material dropping inside the schooner-body, to go loose and wandering in the mud, — in lack of the finer rock-filling spilling outside of load, — is fully a hundred years behind the principles of M'Adam, and thousands of years behind the ancient lessons of the best gravel knoll described on the first page of this essay. If we allow these blind road machinists to lead us, we shall be as well off in the ditch as in the middle of the road.

A word to the wise is sufficient, but something more is needed for the foolish. Let us bear in mind our grand distances of wealthy farming country, whose only real protection is the impassable nature of its highways; where the traveller for long mud-stretches has to work his passage by frequently alighting from the vehicle; where it is a constant chore to disentangle his wheels from the tenacious clay that has filled his spokes as solid as the paddles of a churn just before the butter comes; where masses of the chafing material either lock his wheels or threaten to swamp his wagon-bed. Under these circumstances it is proper to make the sign of caution to those who so urge the claims of road machinery, as to aggravate the sticky situation, east and west, north and south, by filling the clay with loose, sharp rocks, even more treacherous in waylaying the traveller than the quaking mire alone. It is time to call a halt in highway talk for the best repute of road machinery.

There are thousands and thousands of places, where narrow ribbands of unequally broken stone, laid really solid, and well supported according to the strict principles of M'Adam, with such local modifications as that naturalistic road maker would be certain to justify if he stood upon the spot, that would be perfect godsends for millions of people, indestructible and millennial thoroughfares, practically everlasting, better than perishable iron roads on wooden foundations, social bonds, liberal educations for the peoples constructing them; but there is only one way to do the work. There must be teams of broad-tired carts driving over every inch of the self-filling material, compacting it as fast as it is dumped and nicely spread on the highway. This is the doctrine for country road making. Every good citizen may see, if he chooses, that the broad-tired cart for city use is the natural forerunner of the narrow-tread steam roller and the traction engine. We must creep before we can run.

We hear of much being done with thin coats of small stone, rolled into sandy or gravelly streets, where the drainage is naturally very good. This "gospel of thinness" is a pretty doctrine; it gives us something to travel on, with the same cost for grading and finishing as if we had a road with a good deal more substance in it. The bottom of our four-inch work is in the dirt, and the top will soon be growing nasty with surface accumulations. It begins to appear, within a year or two, that there are exudations of mud from the subsoil we thought was sandy enough. At last the most sanguine friend of the experiment sees that it was a mistake, and that resurfacing is necessary; but by that time every particle of the four-inch glaze is saturated and slippery with manufactured clay. Too late we recall that M'Adam recommended ten inches of solid stone for the climate of England, where frost is scarcely so severe as in Virginia. Good country roads, to cost little and wear well, must be narrow.

In resurfacing with another thin coat upon the muddy first strata, we are liable to lose in two or three ways, besides the loss and disgrace of doing our work over again. If we do it in a wet time, we shall certainly crush our clean stone into the mud. If we do it in a dry time, we are liable to turn a heavy steam roller into a regular rock-crusher, grinding much small metal to powder between our upper and nether mill-stones. In either case we have incorporated a layer of filth in the heart of our road. Had we applied eight inches of solid stone with broad-tired carts in the first place, we should feel at least four times as secure from internal friction, with every particle of material slipping and sliding upon every other one, and grinding to destruction under moderate city traffic. The sooner our steam roller and rock crusher brethren discover that the gentle pursuasion of the broad cart wheel, delivering metal filled with its own hard binding, will enable us to lay down solid rock-road at one operation, complete for a life-time, the better it will be for all of us.

The good stone man of this stone age will most intelligently consider the pockets of his masters when he minds least what they ignorantly say, and is most delicately sensitive to the durability of the metal he employs in road making. He should never be satisfied with a road that changes at all except by surface friction, and the matter loosened by that should be washed away by every rattling shower. One of Telford's few remarks was, that "a good road will be so shaped as to clean itself." To do this long in the busy main street of a city or village, everybody must say the new work is "too high," at first; but they will presently get used to that, as they do to any new fashion, and employ themselves with some other nine-days' wonder. The best road maker will feel, however, that he is but a necessary evil, and that the streets are not kept solely for his exploits and perambulations.

Now, we hear much said, by those who have been abroad, of the fine roads that are seen there; and we are invited to consider the European plan of keeping our roads up.* It seems to make no difference in Europe how the roads are constructed in the first place, because the "maintenance" is so thorough, being sustained to a considerable extent by American travel and cheap bread. Great gangs of men, with gypsy-wagons to live in, are continually moving about the country, doing something to the roads; but the finest thing about the "system" is, that men are stationed at short intervals, to do whatever the great gangs forget or neglect. By the accounts we get, the roads in some parts of Europe are lined with make-believe menders. If armies were being disbanded to starve, there might be some sense in giving old heroes a chance to glean a living on the highway, and road superintendents would be excusable, in a charitable point of view, for leaving small jobs of work for industrious old gleaners to pick up. But how about road making as a business, where the porous work shows most contrivance to make work? According to this European plan, American roads have places at the present time for several millions of government employees, — or will, when they are thoroughly organized on the European plan. It may be observed in passing that a great many people are running away from that European system. Resident land-owners taking pride in their own roads might do the work much better and cheaper.

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* W. C. Oastler, C. E., New York, says: "In London, where there are 1,800 miles of broken-stone roads, and more than fifty steam rollers, the stone is brought 150 miles, and when it is delivered ready for use it costs $4.25 (17s. 9d.) per cubic yard." If the measure is not quite half air, we can see that a road-stone quarry is better than a gold mine.

Looking charitably at our Eastern cities, it would seem as if the gleaning plan was in full operation. Streets are opened and treated, not with a strong desire to show the best possible road making, of stone or anything else, but apparently, by constant changes of mismanagement, to leave as much as possible of the people's substance to be gleaned under the head of "maintenance."

The question will arise, and will be presented sharply for reply: Is this legitimate business, applicable to the whole country, or are we spending our children's patrimony of good-will and the fruits of the earth for perishable extravagances in road making? Can the two Dakotas make a profit on "eighty-five-cent wheat at Atlantic ports," that will enable them to lay down long lines of "Telford-Macadam," with picturesque vistas of road-mending stations for maintenance? Can we afford to make mistakes in letting precious road-stone go wandering through the mud of any part of our great mid-country? What is good for Dakota is good for Massachusetts or Connecticut in this railway age.

These questions answer themselves plainly enough in our own minds. Thoughtful Americans will perceive that, if we desire better roads anywhere, — as who does not? — it is our first duty to learn our road-making trades. Let us have State surveys and topographic maps in every household, so that we can all see which way our roads should run; and, while these surveys are being made and new model hand-tools, vehicles and machinery put in a state of forwardness, let every town, county and State try to conceive and bring forth a quarter of a mile of road that will not require a standing army of road menders for its maintenance. Mountains of rocks are waiting to be fabricated into paths of peace and pleasantness. Let us begin with samples of road wherever fit workmen and material can be got together, with their keeping up, wrought into their solid foundations; and let us have men engaged in the construction of roads who are not gainers by their early destruction. The field is large enough for all the world to work in.

The American mind runs to monopoly as naturally as water runs down hill. Nature herself keeps road-stone where it is hard to get. But a State government that is good for anything ought to be good for opening and testing stone-road quarries. State chemists should have been ready, long ago, with the composition of the best country roads. Limestone quarries yawn with the tedium of waiting to be tested more intelligently than they have ever been. Who knows what a little dust of iron will do in a broken limestone road?

In sight of an ignorant and heedless public, good quarries may be be beaten out of use by conniving officials, and replaced by inferior metal. A first-rate roadstone can better afford to *give* itself to be rightly used than to sell at any price for a blundering street.

Last March, in Salisbury, England, where flints are plenty, I found a short, red-faced official, watching, with a steam roller, the crushing of limestone into the mud of a narrow thoroughfare.

"Better 'n flints?" I asked at his elbow.

"We are trying an *experiment.* The limestone quarry people have influence with the Board."

"P'raps the flints have been mismanaged?"

"Well,"—with a wink,—"there may have been some o' that!"

"But do *you* think the limestone a better metal?"

"*No,—I don't.*"

That was good English for me. The ignorant taxpayers on that street were being worked for all they were worth,—whether with limestone or flints. The delicious harmonies

I had just before heard floating among the arches of the grand old cathedral had to be averaged with these street-discords in my Yankee mind. "Make ye your paths *straight*," is a good word for modern roads.

Road making could be taught and learned much more effectively, were the real materials here present in the hands of experts. If a few barrels of fit earths, gravels and broken rocks were at hand, with water for tempering and means for manipulating them in trough-like road-bottoms in miniature, it would not be in the least difficult to make public exhibitions, over and over again, of every needful point in the business, so a child need not err therein. Every fair-ground should be utilized for that purpose, on larger scales than would be as easy under cover. We are being regularly educated now to let road mending be a lucrative business for others than ourselves. Available sources of this or that substance are owned by parties who can well afford to teach us to forget and forego the right use of our own materials, and give them a perpetual income. It is a wonder we are not importing material for country roads, as we do peat-bedding for horses.

A grand object lesson for a sleepy farmers' meeting, during the present phases of indoor road study, would be to have not a ray of light in the room for a moment, except what shone from an inch of tallow-dip, lighted on the speaker's desk, with about a peck of "even-sized" broken stone piled up around it. That would exceed any electric light, yet, in our business!

Every local road-job has its own laws and conditions to be studied, perhaps to break them. These are too many for this place. Often the wilfulness of some private individual is a snag to be avoided if possible. Once I found five hundred loads of village rubbish lying on top of the gravel I wanted. In that case after needful diplomacy, I made a special stretch of public road, where a fill was advisable, to hold that rubbish. Forty big loads of old spring-beds, kitchen boilers, stove-pipe, iron-hoops, tin cans, umbrellas, etc., went into the bottom of a very good bit of wheeling, where it was miry before, — to the great astonishment of by-standers. The party of action requires some nerve in such cases; but all is well that ends well. The good road-mender must have a place for and be ready for anything. He is liable to be called to bury dead horses and receive a delegation of village women at the same moment, when highway, street and side-walk concerns become lively.

We have run through the whole list of road-stuff, from native brush, sands, earths, gravels, wood in various forms, cobble stones and broken rock, furnace-slag, clinkers, and a great variety of pavements to railway iron and steel, — all good in their places, — yet never, as a whole people, thoroughly understanding any of them. We allow ourselves to be rushed from one expense to another, as if road material was a matter of fashion, like the shape of a hat or coat.

The city engineering plan of piling each size of stone in separate layers, is nothing but the old wood-chopper's trick for making their cords bulky, and measure more by the air-spaces in them. Stone crushers by the yard gain by measuring their sizes separately. Laborers understand the trick. If they wink at our cheating, we must wink at theirs. When any engineer tells of these things, the rings maul him to death, and nobody minds. Road-stone should be sold by weight, or cubic measure, after it is well built, like brick or stone wall.

We can show visiting strangers some fine streets, while they are new and fresh from the mud-starch and ironing of the steam roller. But why don't they wear longer? What makes these depressions after a few months or years? Why do they shake us so?

The trouble comes from "porous" road making. Our honeycomb arrangement of stone and air has caved in. Our road-cake has "fallen from the crust." Clay or street filth has gushed in among the rounded stone. The skim-coat of screenings has blown into people's houses, or worked, as greasy mud, into the leaching foundation. Rains, freezing and thawing, the wringing pressure of wheels trembling under heavy traffic, have destroyed the admired steam-roller polish. Let us drive on some new street. Soon there will be a call for "resurfacing," and so the bad work goes on.

The evil of dust, with its discomfort, dirt, and possible dissemination of diseases from streets, is greatly aggravated during drouths by the "porous" arrangement of stone in so-called "macadam" roads. Artificial waterings and the water of rains are wasted in the loose material that is never dampened by capillary moisture so as to hold its own dust from blowing. Dry stone is softer, crushes easier and more thoroughly under the wheels of travel; while solid broken stone, firmly seated upon the cool moisture of the earth, would be liable to none of the mischances we are mentioning. Such broad "macadam" streets as we sometimes manufacture are but narrow Saharas, liable to fierce dust storms. It would be better to break the centres of some of them with lines of shade trees, shrubbery, flowers and grass.

Old stone roads mismanaged in making are not even good foundations for new ones, albeit M'Adam had to use them. They are worth no more than dirty rock, free of cartage, and might well be lifted, rain-washed, broken over again, and relaid as M'Adam did in similar cases, with betterments as aforesaid, that he would approve to-day.

When we have learned to build solid and smooth stone roads, wearing only from surface friction, fewer horse or other railways will be in demand. These live by popular ignorance of stone and gravel road making. We can see, better than we can describe, how a succession of stupid road-menders furnish tramways their opportunity. They and their gangs like porous stone-work to lay their frequent spruce sleepers in. Porous street substances furnish easy and continual diggings. The rattle and roar of business goes on, and the people pay more taxes in new forms.

Sweet, springy and elastic earthen roads, as made by old-style New England artists and farmers, furnish the pleasantest tracks man ever drove a horse on. Narrow, rounding and dry, with scarcely perceptible water-bars, in a delectable hill country, the roads I have in mind — not too much travelled — are delightful to walk over, alone or in good company. There are thousands of places in the country, where, after constructing the best possible roads of gravel or broken stone, it might be well to dress the narrow highway every spring with plastic, fibrous loam, just for the use of driving on it in summer time. It is political economy, as well as the highest art, for the country to make itself attractive to the town, in all gentle, graceful and natural ways. What is not forest should be garden and park. Not a single item of farm thrift hinders. Trees, shrubs and vines come by chance along many country roadsides, which may be more beautiful than anything we can plant there, if we clip obvious weeds, and show nooks and bays of greensward among the low groups and towers of foliage.

City people spend millions, yearly, to get a rest from the din of their own devices. Would not some part of the labor we spend in glutting far-away city markets over poor highways, be better expended in making rural roads and roadsides so lovely as to bring the best citizens to our doors? It may be a slow but it will be a sure speculation, if we go the right way to work. We need first to settle ourselves comfortably. Road making is but a subordinate branch of gardening, and we may make gardens of our roadsides.

The CHAIRMAN. Secretary Sessions has a letter which he thinks is appropriate at this time, if you will give your attention.

TOLLAND, MASS., Dec. 1, 1891.

To the State Board of Agriculture.

GENTLEMEN: — I should be very much pleased to attend your meetings this week if I could. I feel very much interested in the subject of country roads. We are eighteen miles from railroad, over very heavy hills and mountains. Our roads could be very much improved if we had the money to do it. We are thinly settled, have a large piece of road to every man, to be kept in the best repair we are able. We can barely make them passable, without making any improvements on them. Our hills are steep grade. Many of them need the location changed, others can be improved by grading. One particular place I will name, in the town of Granville, on our mail route. After climbing up a hard mountain, over one-half mile, we then have to rise one hundred feet higher, over a very heavy grade of rocky, ledgy road, to fall down another steep grade. This might all be saved by a short change in the location, and one hundred feet of rise and fall. There are many places on our roads similar to this that greatly need work done. Our mountain towns are poor, our population decreasing, and our taxes are two mills on the dollar. We are not able to do what very much needs to be done to our roads. Our roadways are so rocky that we cannot work road machines to much advantage. We pay our taxes to the State, and we feel that the State should help us to have at least one road for a mail route that is better than we are able to have ourselves. Our roads are now travelled mostly where they were located when the country was first settled, before the art of road making was known.

Hoping that your meeting may lead to a betterment of our country roads, I remain yours, FOWLER T. MOORE,

Road Commissioner.

The CHAIRMAN. Gentlemen, you have listened to a very interesting lecture from the essayist of the afternoon. The Board has invited every road surveyor in every city and town in this Commonwealth to join with us this afternoon in the discussion of the question. It has also invited gentlemen connected with the carriage interest and the horse interest to be here and take part with us. I think some of them are here. The essayist has referred to the roadsides in the country. That is a subject which interests every community; and it is our duty to consider the State as a whole, the future of the State in all its departments, the care of it not only for the present generation, but for all future generations, — to look after it, protect it and promote its interests. We have a gentleman here to-day who is extremely interested in the character of the roadsides of the Commonwealth, and we should be very glad to hear from him. He is a gentleman who is very much interested in the preservation of all places of historical interest, and all places of natural beauty and attractiveness. We should be very glad to hear from Mr. CHARLES ELLIOT of Boston.

Mr. ELLIOT. I have very much enjoyed the talk which the lecturer has given us. It is true that I feel a very deep interest in the roads and roadsides of the State. I am familiar with many townships where the beauty of the roadsides is so much a source of attraction that one might say they are a part of the financial capital of the township, drawing people from far and near on account of the beauty of the scenery, and the roadsides are part of the scenery.

It seems to me that a great many of the townships in this State would be consulting their best interests if they would pay much more attention than they do to that side of the subject. Not only should they make their roadways better, but they should take more pains with the roadsides. The town of Brookline, which is supposed to be the richest town in the State, shows something of what might be done. Those who are familiar with it know that the roadsides are in most parts of the town very charming, and those who are still more familiar with it know that the roadsides are cared for by special committees, who are empowered to plant trees, to cut the grass, and to do this, that and the other thing, as they may see fit. I only mention that town because it is a very conspicuous example of what our roadsides may be. The preservation of everything that is beautiful in the natural scenery of the State I believe to be a very important thing for this Massachusetts of ours. It is going to be, in a future time, if we are careful and look alive in these matters, a place of great resort for people from our Western country, — a country with by no means as much natural beauty as this of ours; and those towns which look sharpest after this matter are certain to be the towns which will be chosen for the happiness and enjoyment of the people who come here. The people here present, if they care to hear something more on this subject, will be glad, I know, to listen to a friend of mine who has lately been making a journey through all the sea-coast towns of the State, to see what they are doing and to see how much they are making of this very thing, — because it is the sea-coast that will be most resorted to, undoubtedly, in this search for pleasant summer resorts. I hope, Mr. Chairman, you will call upon Mr. Harrison of New Hampshire, who happens to be here this afternoon, but has to go away shortly.

The Chairman. I shall take pleasure in calling upon the gentleman, but before introducing him let me call the attention of this audience to the fact, which I think is a very important point, that many of those shrubs which we find upon our roadsides, and which many of us are in the habit of cutting down, are to-day exported to England and other countries, where they are grown in nurseries as prized things. I take pleasure in introducing to you Mr. HARRISON. He is a gentleman who has been interested in the preservation and protection of woodlands and forests as public reservations for the good of the people of New England.

Mr. HARRISON. Mr. Chairman, Ladies and Gentlemen: A few weeks ago I was in the town of Manchester and over in the town of Essex, and I found a feature of the roads of that region which was very interesting to me. An arrangement was made some years ago by which a plat of land on each side of the road from Manchester to Essex was purchased, largely by the efforts of some public-spirited women in the neighborhood, and the deeds of the land deposited in the office of the town clerk. The title is in the town. These ladies, driving frequently along the road between Manchester and Essex some years ago, found that much of the beauty of the roadsides was in danger of being destroyed by cutting away the shrubs and bushes on each side of the road. They thought about it and conferred with each other until it seemed to them a very important thing for the summer visitors to that region, and for the young people who were growing up in that neighborhood, that the growth of trees and shrubbery at the sides of that roadway should be preserved. They talked about it and thought about it and wrote about it, until they effected an arrangement by which the necessary funds were provided and this strip of land on each side of that highway was purchased; and, the title being in the town, it seems a very effectual accomplishment in that direction. Everything indicates that the scenery there will be preserved permanently, and that that road, at least, is likely to be for a long time, or for all time, a beautiful place, a drive attractive to everybody with any sense of natural beauty; and I learned that so great is the interest in and satisfaction with the road that it is exerting a very favorable influence upon the price of land along it, and the general attractiveness of the region causes the land to be more and more in request.

I do not know that that example can be very generally or widely followed, but certainly it is something that deserves an intelligent and respectful recognition that we have here such an example; and it is interesting to observe, as I have said, that it comes so largely from the thoughtfulness of some of the intelligent women of that neighborhood.

It appears to me that the need in this direction is largely that of public education and discussion, and that hardly anything adequate at all can be done in this State unless we begin to a very great extent at the beginning of things, as you are beginning here in this meeting to present the facts first and then the principles which obviously relate to these facts, so that we can have a little advance in civilization in relation to these subjects. People have to do new things, and disuse some of the old ways of doing things. There must be some advance in popular thought and in popular intelligence, perhaps, before anything adequate can be accomplished.

One thing presses upon me when I think on this subject, and that is the curious fact of so great a movement going on towards the shore region of New England, with, at the same time, so slight recognition of such a movement among the people. A little while ago, as my friend Mr. Elliot remarked, I was through the shore towns of Massachusetts, and everywhere I found indications of this movement. There is not a shore town in the State to-day, Mr. Chairman, in which there is not going on a change in the ownership of land; and yet very few people in the towns where this change is taking place recognize that there is any movement. When I visited the citizens along the shore and the town officers and the leading men, and asked them about it, very commonly the answer would be, "No, there is nothing especial going on here; things are just about as they have been always." Of course there are towns in which this is not the case, but in many towns I was told: "No, there is nothing particular here. Somebody has bought this farm down here and a land company has taken up something of an area over on this side, and we have heard that in the next town there have been several places bought within a year or two." But very few people put these things together, and many people in the State do not perceive that these changes in their towns indicate any general movement at all. They do not exercise their imagination about what goes on, except in their own town or perhaps in the immediately adjoining towns which they have heard about.

In every town along the coast of the State there has been during the last few years especially an incursion of people from outside, for the purpose of acquiring ownership of land. Some of the citizens tell me they are buying for men in New York, for men in Boston, for men as far West as St. Louis and Minneapolis, even; that they have been employed by a company here or there to acquaint them with any opportunities for the quiet acquisition of land. Of course these purchasers do not wish to come into competition with themselves, they do not wish to have it known that they want to buy eligible places, they do not wish to have prices advanced upon them; but in all the shore towns of the State there is something of this movement going forward, — in some, of course, much more than in others. If we could see all the people as far West as the western side of the Mississippi valley who are setting their faces towards the shore towns of New England, it would be a charming and impressive spectacle; but of course we cannot see how many they are, and they are buying our land away from us almost without our knowing it. In several instances which came to my knowledge the old holders of the land were very much astonished that anybody should want their land at all, or offer any price for it. They found it very difficult to realize that it was worth more to anybody else than it was to them, and they were rather surprised that anybody should think of giving the sum of money that they were disposed to sell for. Instances like this exist in many of the towns of Massachusetts. People who own an acre or two on the shore do not think much of their ownership; but when men come to own three or four miles of shore land they think it almost invaluable. The way in which we treat our roadsides is going to have much to do with this movement. If we can add to their beauty, we shall increase the attractions which we have here in this beautiful State of Massachusetts.

The CHAIRMAN. We are very glad to hear from Mr. Harrison; and, if there is any other gentleman present who is inclined to speak from the same stand-point, we shall be very glad to hear from him. A number of gentlemen have been invited to come here, and, if any of them are present, we shall be very glad to hear from them before I call upon anybody to speak.

F. W. Sargent (of Amesbury). We have present with us Mr. Mann of Methuen, who I understand has just completed a large contract for road making.

Charles W. Mann (of Methuen). I will not speak about the work I have done; perhaps it will show for itself. It is only a small job. In our town of Methuen we are becoming greatly interested in good roads. The beginning of that interest was perhaps two years ago, when our town warrant had an article in it calling for an appropriation of ten thousand dollars for pavement. That is likely to interest any small town. But there were some other articles, and they were referred to a committee of three, of which I had the pleasure of being one. After the committee was appointed we went down to Bridgeport, and, through the information obtained from Mr. B. D. Pierce, the street commissioner of Bridgeport, we have got started in a way of building streets at a very low cost. On our visit there he took us over some fifteen or twenty miles of streets which were in better condition than we had ever seen in any city of its size. His method of building is first to have a well-drained road-bed; it seems to make very little difference to him what the material is. He will take any old road, and work it so that it will show a crown of from twelve to eighteen inches, which makes a perfect water-shed. Then he rolls it thoroughly with a steam roller, which gives a very solid, hard bed. Then one coating of two-inch crushed stone is applied, just so they will cover the ground, making a coating two inches thick. That is screened stone of even size. Then upon that, when thoroughly rolled, is placed a layer of smaller stone, perhaps crushed to the size of an inch. Then the last coat is applied of screened stone, such as are used in this city for private walks and sidewalks. That coating is applied and thoroughly watered and rolled until the water will flush in front of the roller. If you can find sixty miles of driveway built for the sum which he told me those roads cost, which I think was less than two hundred thousand dollars, I would go a great many miles to see them.

The Telford-Macadam road which has been described here is built from two to three feet deep, at an expense of perhaps six times as much as the roads to which I have referred cost. Mr. Pierce showed me places where a Telford road which had been made several years had to be dressed up every year to keep it reasonably smooth, while for five years a four-inch road by the side of it was as smooth as need be. The repairing of these roads is a very easy matter. In five or ten years, if the top coating wears off, it is a very simple matter to break it up and then put on another coating of small stone and thoroughly roll it, when the road will be as good as new, and at very little expense.

The result of our work in Methuen is, that in two years we have built half a mile of street about forty-four feet in width, macadamizing it in that way, and making a very fine avenue of it, at an expense of five thousand dollars. We think that to have paved that same amount would have cost over thirty thousand dollars, and this street is very much preferable to drive over. The expense of keeping it in repair perhaps will be a little more; but the interest on the money that would have been spent for paving will be more than sufficient to meet the extra cost of repairs. This method perhaps would not be so well adapted to our country roads; but take our common country roads, where they are only from twelve to twenty feet wide, round them up, roll them thoroughly, and then put on six inches or even eight or ten inches of stone, and roll it down well, and I believe it would give you a permanent road at very small cost; for in many places there are almost stone enough going to waste by the roadside which can be very easily and cheaply worked into good material for a road-bed. I believe that the system of road-building and the character of the roads in our country towns are almost altogether wrong. It seems that the man who can get the most votes, whatever his knowledge or lack of knowledge is, takes the charge of the roads in our country towns; and I know that in places very near Methuen there are two sets of men running from one end of the town to the other for three weeks before town-meeting day to get votes for this man and the other for road commissioner, and oftentimes they peddle a good deal of hard cider to get them. I believe the man who is to have charge of the roads should be educated for his work as well as a high-school teacher should know his work. I think it would be a long time before we would elect a high-school teacher by popular election. There may be between two cities or towns a poor town, too poor to build and maintain proper roads; and in such cases I believe it would be better for both of those cities or towns and for the intervening territory if the roads could be put under the charge of the county. We could then have good roads, such as the poor towns between cannot afford to build. Perhaps the time has not come for that yet; but, if it has not come, I believe it is on the way or will shortly be on the way.

Question. How long do you think Mr. Pierce's road would stand the traffic between Quincy and Boston?

Mr. Mann. I do not know just what the travel is in Bridgeport, but I know that there are three hundred tons of freight carried over the streets every day.

Question. In what kind of teams is it carried?

Mr. Mann. It is carried in heavy carts with narrow wheels, probably, as every man does and should not do.

Question. Will they weigh six tons?

Mr. Mann. I could not say as to that; but Mr. Pierce told me that Barnum moved some of his paraphernalia that weighed something like twenty tons over one of those four-inch roads, and it stood up.

Mr. ——. I have heard a good deal about Mr. Pierce's four-inch macadam road, and I would like to get some facts about it. I do not believe such a road would be adapted to the requirements of a road between Quincy and Boston, for instance, where the loads will vary from ten to forty tons.

Mr. Mann. There may be some places where the loads are so heavy that nothing will stand them but granite pavement.

Mr. ——. This Telford road does stand it.

Mr. Mann. It did not stand it in Bridgeport.

Mr. ——. I can assure you that there is a Telford road in Quincy that was built four years ago, and it stands.

The Chairman. The great question seems to be how to secure good country roads. The cost of such roads bears heavily upon the country towns, not so heavily upon a city. How shall it be equalized? How can we have good country roads throughout the State, and how shall we assess the expense of doing it? That question is before us, and we hope to hear from other gentlemen who are interested in it.

Mr. Thurston (of Swanzey). There is no question but what we all agree to the necessity of having better country roads. The town of Swanzey the past year made a trial with one surveyor; a year ago they had three; before that they had ten. We have now got down to one, and we think that we are progressing in the right direction, and hope to get roads, if we can get the right kind of help, that will be satisfactory. We have the city of Fall River four miles from us on one side and the city of Providence fifteen miles from us on the other side, one having a population of eighty thousand and the other of one hundred and twenty thousand. We have a bridge and eight miles of street in our town, over which the traffic from those two cities passes; and the question has been, how we can take care of that eight miles of road, and at the same time take care of the forty-four miles of other roads belonging to our town that are feeders to this main road. The people in the town of Swanzey want to have good roads. One-third of all the money, ten thousand dollars, that we raise on a valuation of seven hundred and fifty thousand dollars, is spent on our highways, one-third is spent for our schools, and the balance for our State, county and town expenses outside of our highways; and yet our roads are in poor condition, and they never can be any better, I fear, unless somebody comes to our help. I think that is the condition of a great many towns in this Commonwealth. I have travelled over many roads in the neighborhood of Worcester, and from there to Boston. I understand the question before us this afternoon is "How can the country roads be improved?" We have been told it can be done through educational means. I think the State should come to the rescue of those towns, as it has come to their rescue on the subject of education. Most of you know the laws that have been passed within two or three years to help the smaller towns in the matter of education, and a noble work is being done through them. I believe that if the State will come in some way,—I do not know how, but by a proper investigation the way will be found,—if the State will come to the assistance of the towns, and help them in maintaining those through roads, then in all probability the towns will take care of the local roads. I have a resolution which I would like to offer, if I may.

The CHAIRMAN. Any resolution expressing the opinion of those who are here present is perfectly in order. I see no objection to it. Of course it is not in order, if intended as an expression of the opinion of the Board of Agriculture.

Mr. Thurston submitted the following resolutions:—

Resolved, That the State Board of Agriculture, at its public meeting, held Dec. 1, 2 and 3, 1891, recommends such legislation as shall induce the towns of the Commonwealth to increase their appropriations for highway purposes.

Resolved, That it is expedient, and will conduce to the safety and better condition of the highways and bridges in this Commonwealth, that a State highway engineer and superintendent of bridges should be appointed.

Mr. Thurston, continuing his remarks, said: I think these are two questions which have been before the Legislature and have been investigated by legislative committees, who, however, have failed to make any recommendation on the subject. It seems to me that we need the last as much as we need the first.

Secretary SESSIONS. I think it should be understood that the passage of the resolutions does not bind the State Board of Agriculture, because this is not a meeting of that Board.

Mr. BOWKER. I believe that Mr. Thurston is in earnest, and honestly endeavoring to have this Board accomplish something. I will move that the resolutions be referred to the State Board of Agriculture at its annual meeting.

Secretary SESSIONS. If it is desired to get an expression of the opinion of the Board of Agriculture upon this matter, that is the only way in which a legal expression can be got. This is not a legally warned meeting of the Board; and, as you all understand, at this late hour of the closing session of the public winter meeting there is probably not a quorum of the Board of Agriculture present. I have no doubt the Board of Agriculture at its annual meeting will be glad to discuss this matter, and take action upon it in some form.

The CHAIRMAN. The chairman understands that Mr. Bowker moves that these resolutions be referred to the Board of Agriculture.

The question was put, and the motion of Mr. Bowker declared carried.

The CHAIRMAN. Will the gentleman make any motion calling for an expression of opinion from the gentlemen present? The subject before us is a very interesting one. Does any other gentleman desire to speak upon it?

Mr. ——. I want simply to make one suggestion here to whatever representatives there may be present from the different towns in this Commonwealth. It is with reference to something to which very little attention has been paid in the past, as far as my knowledge goes; and that is, that the towns have not been at all particular in the choice of the men whom they have placed in charge of their roads. When the citizens of the towns become so much interested in having good roads that they will see to it that they put the very best men they have in charge of their roads, they will have taken one step towards the solution of this question. I know of what I speak. We have had some experience in our town. The fact is, as has been stated here, that the man who can get the greatest number of votes gets the position of highway surveyor, and in nine cases out of ten it turns out that he is the very worst man for the place that could be found.

Mr. BOWKER. I think the gentleman has made a good suggestion. It seems to me that this Board might well take some of the money which it has been expending in Massachusetts, and use it in teaching practical road making to the road makers of the State, going into the field and making field demonstrations, if I may so term them. We have had a great deal of talk about field work, and why can we not have demonstrations in the field of the practical work of road building, to which the highway surveyors may be invited and at which they can get the desired education? I have listened with a great deal of interest to the paper which has been read this afternoon, and, if we could have had before us on the platform a section of a road built as it ought to be built, with the required material shown, and then alongside of it a section of road built as it ought not to be built, it would have taught us more than page after page of the lecture. That is the kind of practical demonstration that we want in every department over which this Board presides.

Now, I want to make one reference to the roadsides, because it is of interest to every citizen of the State who owns a farm and who may some time want to sell it, and especially if he owns a farm in one of our beautiful back country towns. I happen to have a farm where I live in the summer in a beautiful place away up on the hills. A real-estate man came to me the other day here in Boston and said, "I took a gentleman up to your town and showed him some farms there for sale, and I should have sold him one of them but that he was not pleased with the roadsides." They had literally been ruined, and all because of the *thriftiness* of the farmers; for the town is a thrifty town, and every roadside must be cleared of brakes and brush, as they are termed. Some of those very brakes and brush are what I saw this last summer in Europe, in some of the best greenhouses and gardens which I visited. They were carried over there as rare specimens, and yet we are mowing them down; and then, as a gentleman who came from the other side said to me, "We bring them back here and pay high prices for them." I have always lived on a farm, more or less, and have owned one for a number of years. I have been guilty of recklessly mowing the roadside for eleven years; I shall never do so again. I am going to let the little elms, the beautiful maples, beeches and birches which have started up, and got such a start as only a natural tree that comes from the seed can get, — I am going to weed out the rest, — and let these saplings grow into beautiful trees.

That is the way to plant trees by the roadside; and, if we had adopted that plan twenty-five years ago, every road in this State would have been a beautiful avenue, protected in summer and sheltered in winter.

There is still another point I want to touch upon, and perhaps I shall touch the manufacturers of road scrapers. I do not want to do anybody an injustice, but I do think that the road scraper *in unskilful hands* is the worst machine that was ever brought into a town. The idea of scraping back into the centre of a road the old worn-out dust that has been ground and ground for the last twenty years into an impalpable powder, and calling it a road, is absurd. It makes that same kind of mud that we have been talking about this afternoon. Up in Concord, Mass., they do things pretty well. They teach us philosophy, and they have taught us something about road making. Up there they have got some pretty good roads, and they make them by carting the worn-out material away and then carting in fresh gravel, and their roads are among the best that you will find in the State. They employ as road commissioners three of the best men in the town, and one of them, I think, is an engineer. I think the suggestion of the gentleman on my left is one of the best that has been made here. Get the right men, and then, when we get the right men, this Board some day will help to teach them how to do their work properly.

The CHAIRMAN. There are two speakers present, one of whom comes from the most beautiful locality, perhaps, that I know of. I enjoy it every time I see it, and I do not see it often enough. The roadsides have no fences; there are beautiful trees and nice houses. I refer to the town of Greenfield. We have a gentleman with us who always entertains us, and we are always delighted to hear from him. I wish Mr. GRINNELL would say something to us on the subject of doing away with wayside fences.

Mr. GRINNELL. I am afraid, Mr. Chairman, that you have "waked up the wrong passenger." Doing away with fences is prevailing to a considerable extent. In a village where a house is as high or higher than the street, it does very well. If a house is not so high as the street, the æsthetic effect is very bad; the house does not look so well and the road does not look so well. Then there is another thing. If your house stands on a corner lot in a village you cannot remove your fence, because, if you do, every child and every dog goes over your land.

I have never known any serious difficulty occurring from the removal of fences along the country roads. We have for many years been strict in regard to allowing cattle to run at large, and we suffer very little from that source. I constantly see cattle driven from one point to another, through streets and across the country, and very seldom is there any mischief done. The men who drive cattle are anxious, on account of the law or from the kindness of disposition which is inherent in every man who cultivates the soil, to take care of their cattle. The removal of fences is a most desirable thing; it is more desirable than almost anything else in the management of our farms. If we could remove the interior fences, except those that are necessary to guard the cultivated land from our stock, it would be of the greatest assistance to us in our farming operations. It would be a very desirable thing to remove the fences so as to have clear fields, parallelograms or squares, where you can drive your horses right up to where the fence was, turn and come back, and cut a long, straight furrow. Plough with horses with such a plough as you think best, harrow the ground with the Dow or Randall harrow, then follow it with the Thomas and make a good seed-bed; plant your corn (I am talking about that particularly now) with a corn-planter and cultivate it with a horse-machine, never putting a hoe into it except perhaps to cut down any straggling weeds. There is not a farmer who has an acre of cultivatable land in this State who cannot raise corn for thirty cents a bushel. I can prove that by better cultivators than I am. We pay sixty cents a bushel for Western corn, when we can grow it here for thirty cents; but our trouble is that it costs so much for labor.

On this roadside question there is much that might be said. Mr. Bowker spoke charmingly about having the roadsides lined with elms and the beautiful maple with its golden leaves, and I, too, admire to see them; but I declare that if I have got to take with them the yellow daisy, the wild carrot, and every one of those pestilent weeds or bushes that grow by our roadsides and ought to be mowed down, I hesitate. No, I do not hesitate. There is no doubt that the legislation in New York which makes it a penal offence for a man to allow weeds to grow by his roadside, like thistles and sedges and the wild carrot, which is one of the most pernicious things, is commendable. The cultivation of our roadsides is a beautiful thing. I have been president of the rural club in our beautiful village of Greenfield, and we take care of our highways. We keep them clean. We, by direct action or by personal influence, persuade the people who own premises by the side of the road to keep them nicely. During the summer season we do not allow any papers or rubbish of any kind to remain in the streets. Our trees are trimmed up. We set out every year two or three hundred trees on the streets leading from the village, — elms and maples; and at about this season of the year we engage a good, judicious man, with one or two assistants, to trim all the trees of the village streets, unless there be objection by the land owners, which seldom occurs. Our new trees that are six, eight or ten years old, were set out, as you know the custom is (and perhaps that is the true way to set out a tree), when they were two, three or four inches in diameter, simply saplings, and allowed to start from the top. In the course of time they make beautiful trees. The little branches that come out from the stalk twelve or fifteen feet high, growing in all directions, horizontally and often downward, should be trimmed off, and the tree gradually trimmed up until you get a regular form, not less than twelve feet from the ground. That throws the sap up into the top; and it is astonishing how quickly you can make a beautiful tree if the trimming is properly done. That is what we do every autumn, as being the most convenient time.

The Chairman. Gentlemen, we have invited here representatives from the carriage industries of Boston. Is there anybody here, from those industries, interested in roads? Is there anybody representing the horse industry, interested in roads? Is there anybody here representing the popular machine of the day, the bicycle? Apparently not.

Gentlemen, we have heard from Connecticut, we have heard from Massachusetts pretty thoroughly; we have not heard from our sister State of Maine. Perhaps Dr. TWITCHELL may have a word or two to say on this subject.

Dr. G. M. TWITCHELL. Mr. Chairman, I received with the programme of these meetings an invitation from the secretary of the State Board of Agriculture to come up if possible and enjoy them with the rest, and I at once began to make preparations to come. I did not come to talk. I have a very good friend down in Maine who has lived with me almost twenty-two years, and her advice has never hurt me. About the last thing she said to me was, "Now, don't bore them by talking." If I do, Mr. Chairman, you must take the responsibility.

I am going to ride nearly all night to-night, because I wanted to be here and hear this question discussed, and I remained this afternoon to enjoy it. It seems to me that in the last half-hour we have been getting down to the heart of things. Mr. Chairman, can I "talk plain?" An old man in our State said to us one day, "I have been having a talk with one of my neighbors, and I guess I talked plain." "What did you say?" "I talked very plain." "What did you say?" "Well, I told him his women folks will steal." Now, the trouble with us in the State of Maine is, that the very men who would be helped most by better roads are the men who prevent better roads. How? They go into town meetings, and as a unit they stand up and vote down any proposition to make the highway tax a money tax. Do you do that in Massachusetts? (A voice, — "No.") Then what I was going to say will not apply to you. If you have got away from that you have got away from one of the greatest evils we have to contend with. They insist upon having the right and privilege of working out their highway tax, and we all know what that work so often amounts to. Then comes in the other evil to which the gentleman on my left alluded, and that is, the selection of men as surveyors who are not fitted for the work. Now, I never would hire a minister to go into a blacksmith shop and shoe my horse; and yet I fancy that here in Massachusetts you have been hiring men to take charge of your roads who were as utterly incapable of doing that work as a minister would be of fitting a shoe. We have in the State of Maine to contend with party ties and bonds. "Why," men say, "he belongs to our party, and we must turn the other man out, and put him in to make our roads." We elect a man who has been disappointed in getting some political office that he wanted and thought he ought to have, make him highway surveyor, and give him twenty-five dollars a year to spend on the roads. There is the evil. When we put business into road making we are going to have better roads, and the only way to do it is to put a man at the head who understands his business. I was glad to hear Mr. Bowker make the remark that he did in regard to having before us a section of road. I felt, all the time the speaker was giving his admirable address, that, if he had only come with a little section of road in a glass case, it would have helped greatly to an appreciation of good road-work. I believe in object lessons in teaching. That is what we are trying to do in our institute work in our State. We want to have the type of the animal or object before us about which we are talking. If we could have had a section of a well-constructed road and one of a poorly constructed road before us, we would have carried home a better impression of what we want than could possibly be given by any description.

Now, we do not like and do not emphasize in the State of Maine the idea of depending so much upon the State government, and going there for assistance. We believe in the State fostering its interests and encouraging its inhabitants. I tell you, gentlemen, that we shall be better men when we have to depend upon ourselves more. Nothing of value in science or art has ever been obtained without labor, or ever will be. I believe that the policy of looking to the State government for appropriations to do this, to do that, and to do everything, is a bad policy. I like the law of New York, to which Mr. Grinnell referred, that makes it a penal offence for any man to neglect to do certain things, — cut the thistles and wastes, etc. I wish we could get such a law through in the State of Maine,—and it would not hurt Massachusetts much.

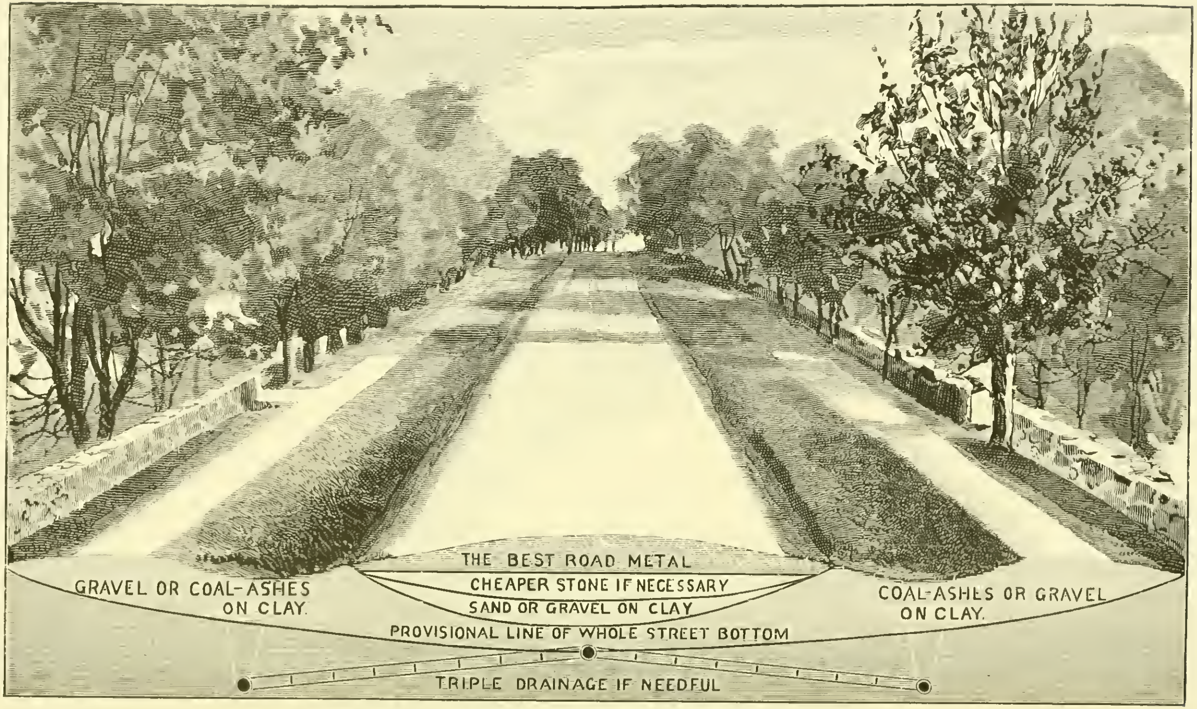
Now, on this matter on the removal of fences, I venture to say that the farms in Greenfield will sell to-day for from fifteen to twenty per cent more than they did before they took away their roadside fences and trimmed their trees. A gentleman came into the State of Maine a few years ago to buy a farm. I went with him into two or three sections, and found a few farms for sale, none of which seemed to please him. Afterwards I met him, and he told me he had purchased. I asked him why he bought there. He said, "Come up, and I will show you." Going into that section, I hunted him up and asked him again why he bought the place. Said he, "I will tell you. The guide-boards at the corners of the roads, the school-houses and the roadsides brought me here." There was hardly a fence to be found anywhere, and the cultivated fields came right up to the roadsides. Last year I drove with my wife through Aroostook County, and for miles and miles I could almost reach from the carriage and pick the wheat heads and the potato blossoms. The fields were cultivated right up to the driveways. There is a picture in my mind of a drive that I took with her a few years ago through another section of the State; and those farms are not advertised in the papers as being for sale. We drove one day about the first of June, when for miles and miles the petals of the apple-blossoms were drifting down on our heads, and the air was sweet with their fragrance. I assure you it left a pleasant impression upon us both.

Now, these are the things, gentlemen, which give value to our premises. Gentlemen of Massachusetts, I should tell the people of Maine, if I were down there, that I believe, if we had given a little more of our thought, a little more of our attention, to these questions, and not spent so much time telling stories around the corner grocery, or discussing the tariff,—if we had put our energies into making our homes more attractive and our roadsides more beautiful, and to securing better roads, as a natural result the farm would have been more attractive to the young people. There is one of the great causes, to my mind, of the difficulty which we constantly meet, of young men objecting so much to remaining upon the farm. You see I come back, no matter what the topic of discussion may be, to the young men, because I have a good deal of sympathy for them. I am a young man myself, in spite of gray hairs, and hope I always shall be. But I tell you these things are of great importance to us who are interested in New England, believing, as we do, that there is a possible future brighter and better for us, and that we can secure more than we have in the past. In order to do this, we must come right down the a, b, c, commencing with our roads and roadsides, our dooryards and our homes, and then reaching out over our farms; and in that way I think that the question will solve itself. Let us never forget that —

"God gives no measure unto man unless by meed of labor,
And cost of worth has always been the closest neighbor;
Up the broad stairs that value rears stand motives beckoning earthward,
To summon men to nobler spheres and lead them worthward."

Mr. Grinnell. Mr. Chairman, the time has about arrived for the close of this meeting. I beg to say, as one coming from the western part of the State, that I think it has been a most successful and agreeable meeting. I think the experiment of having it here in the city of Boston has proved a good one, and much of the pleasure and comfort which we have enjoyed here is due to the generosity of the Massachusetts Horticultural Society. I therefore move that the thanks of the Board of Agriculture be hereby tendered to the officers of the Massachusetts Horticultural Society, for their kind attention in giving us the use of this hall and the facilities appurtenant to it.

This motion was carried, and the meeting then adjourned, *sine die.*


THE BEST ROAD METAL
CHEAPER STONE IF NECESSARY
SAND OR GRAVEL ON CLAY
GRAVEL OR COAL-ASHES ON CLAY.
COAL-ASHES OR GRAVEL ON CLAY.
PROVISIONAL LINE OF WHOLE STREET BOTTOM
TRIPLE DRAINAGE IF NEEDFUL

STREET BEAUTIFUL ON THE AMERICAN PLAN.

APPENDIX TO LECTURE ON COUNTRY ROADS.

PREPARED BY THE AUTHOR, J. B. OLCOTT.

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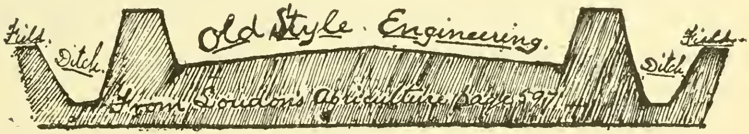
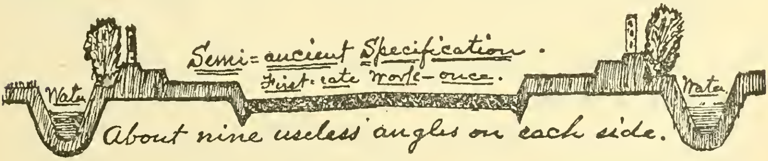
* Illustrations are needed for a number of points in the foregoing essay (and discussion), wherein the strictures upon modern and bogus engineering will apply only, let us hope, to the past. Roughness of execution may be excused in images which are not intended for models, but merely to suggest ideas that ought not to be unfamiliar to any citizen.

To show progress, history is useful, and the inexpert reader may need to see some old forms of road making, designed to keep local labor busy, we may think.


Field.
Ditch.
Old Style Engineering.
From Loudon's Agriculture page 597.
Ditch.
Field.

Those banks of earth were to be crowned with hedges, and the scheme for a road was a survival from the fortifications of walled cities, applied to the highway borders of English farms. With laws made and provided, it is no new thing for engineers to contrive plans for wringing money and property from those who have such, for the benefit of those who have neither.

The following more elaborate plan, from Gillespie, "Roads and Railroads," 1858, taken, probably, from some older book,—shows growth in grace, but the acute reader will see about nine troublesome angles on each side that are unnecessary.


Semi-ancient Specification.
First-rate work—once.
Water.
Water.
About nine useless angles on each side.

These are relics of the abolished feudal ages. Let us beware of feuds from new feudalities. To show that engineering is not immutable, but will change, like other arts, for its bread and butter, this cross-section of Telford's celebrated Holyhead road is given from Gillespie: —

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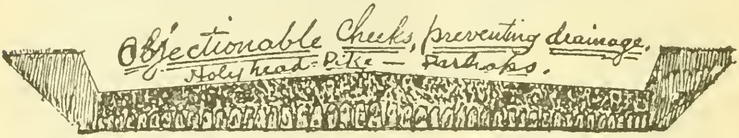
* Seventeen of these illustrations were shown to the convention in large cartoons.



Whether Telford actually did line the road-bottom of Holyhead Pike with larger stones set up on end as above, *without puddling and packing them solid in fine gravel* or *sand*, *over undrained clays*, will not be known unless cuts across his old work are made to show exactly how it was done. But any one who thinks about it must see that, if the bottom course of stone was full of crevices, over wet loam or clay, the soil would be forced up to fill the crevices, and the stone would have to go down under the weight of wheels, leaving corresponding depressions on the finished surface, and making a rough road.

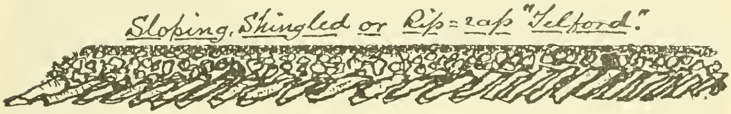
Aside from the above question, Telford may have had two practical advantages in that bottom course of large stone.

First, He could use hard or soft, tough or brittle rubbish stone from fields or quarries that had little value for anything else.

Second, The chipping, trimming and setting up of rough stone in that formal way, if it enabled Telford to call in and pay a sort of skilled labor, paviors and the like, he thus secured a large following to sound his praises. The same conditions exist now.

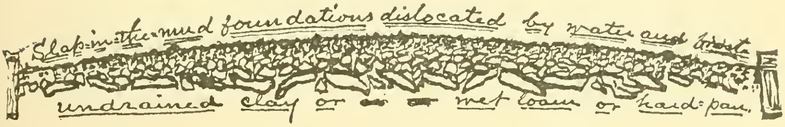
We have in some sections immense quantities of tough, laminate, quarry rubbish and field stones, that cannot be easily broken by hand or machine. These may be stuffed in the deep bottom of a road-bed or dumped in a slough-hole to get rid of them, no doubt, and, with plenty of sand and gravel filling, will help hold up a smooth road. But what needs to be dinned and repeated in the public, tax-paying ear, is, that, no matter in whose name or by what system these rubbish and waste stone are set up in a "porous drainage layer," no smooth wheeling can result. Nature abhors vacuums in the foundations of a road, as the public will when it fully understands how the fine top finish slowly rattles into the open-work bottom, leaving a rough surface for travel.

The popular mind is so confused concerning so-called "Telford" and "Macadam" roads, that some things are done which would be funny were they not so horribly serious in their consequences. We have seen "Telford" road tried with the big stone rip-rapped, sloping or "shingled" in this way, under the wealthiest municipal engineering: —

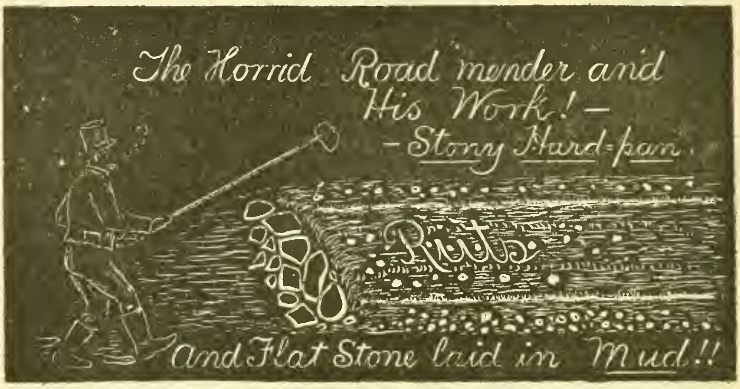


The above section is, of course, lengthwise of the road. Seeing that "regular Telford stone" (as administered in New England), when struck by loaded wheels, would drop into clay, all that will give room for while softened by water and frost, some "practical man" designed this scheme to prevent the trouble by friction. On this road *maybe the travel should be all one way!*

Some other "practical man," and a person of considerable energy and resolution, no doubt, discovering that neither of the above methods were good for anything *as practiced*,— though either might stand if built solid,— concluded it was just as well to throw the bottom stone down flat, and helter-skelter on the clay, since he always found them dislocated in his old street diggings. The following is a fair sample of his best work on this plan, after one open winter: —


Slap-in-the-mud foundations dislocated by water and frost.
undrained clay or wet loam or hard-pan.

The surface of the above cross-section is too smooth. No doubt the steam roller would do such work as that much temporary good; but can we afford to build roads or streets that are constantly settling, and give them up entirely to steam roller perambulations? Yet it is believed some thousands of miles of that kind of road have been made in American cities and towns in their vicinity. The method has been very popular, and we have scarcely begun to look into it. In the country it is now being translated in real life, on precisely the following plan: —


The Horrid Road mender and His Work! —
– Stony Hard-pan
Ruts
And Flat Stone laid in Mud!!

The above picture is taken by permission from the report of the Connecticut Board of Agriculture for 1887. The town where that hopeless work was done, without local remark, is now afflicted by street railways.

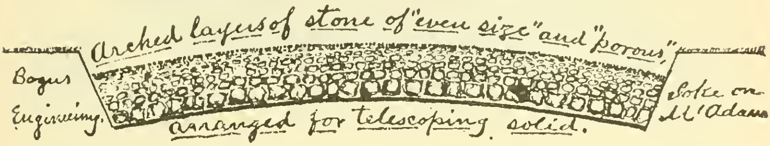
Engineers are giving us "Telford-Macadam," and popular ideas of macadamizing roads are equally mixed. None of our great cyclopedias are clear on the subject of "roads." Zell's (Philadelphia) has this to say: —

> MACADAMIZING. (*Engin.*) A method of road-making characterized by breaking the stone so small that they may form, when covered with a layer of earth, a smooth, solid mass, — so named after the inventor, Jas. MacAdam, a native of Scotland, 1756–1836.

How can a *reading* people know about road making while our books cram one sentence with so many misstatements as that sentence has?

A State secretary of education, having some roads to make, addressed the writer in exactly these words: "Your way of making roads, as I understand it, is to dig a trench, fill it with stones, and cover them with dirt." Hence our pains in this "appendix" are not altogether idle.

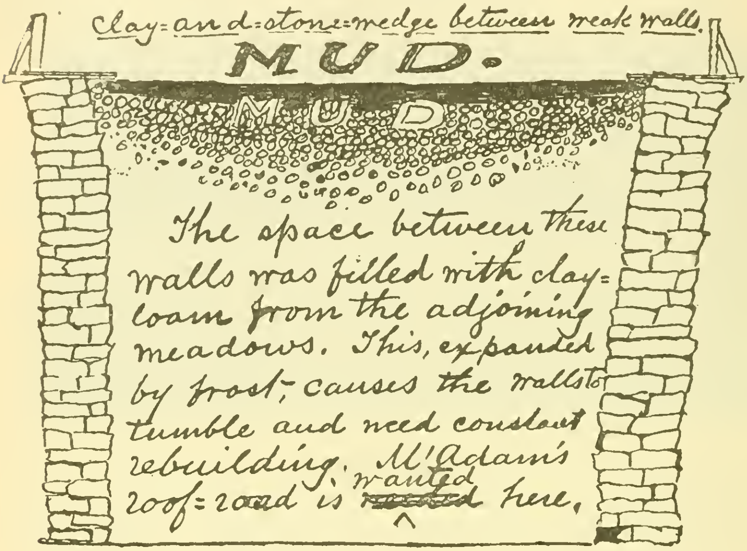
The use of broken stone in layers of assorted sizes over an arched foundation of earth has been recommended by engineering writers and practiced on an innocent public in various places. The theory seems to be that these assorted stones, smaller above the larger to the top, will shut into one another with a telescoping effect under the pressure of travel, and so become very solid. Let us see how this idea looks in a picture:—


Arched layers of stone of "even size" and "porous,"
Bogus Engineering.
arranged for telescoping solid.
Joke on McAdam

The foregoing plan, substantially as represented, was faithfully tried with screened broken rock by a city operator under my own observation, With barrows and planks each class of stone was nicely placed by itself in layers to the top. In the words of an eye witness, "The first four-horse load that ran over it knocked our whole summer's work to smithereens!" It had been heavily hand-rolled,—that arch made the road weaker, more tottering; but perhaps a steam roller, with sections as big as the moon, would have telescoped those stone or ground them to powder.

Man is a terribly ingenious animal. In his pupæ stages he builds, spins and surrounds himself with cocoons of devices which he may cast off and emerge with wings. Everything he does is temporary, but worthy of study. His deeds need not be worshipped except as that strengthens the understanding. Many of his works will be simplified if we consider that he is an industrious creature, and often don't know what to do with his time or money. What he will do, when once his attention is fully turned to country roads, may surpass all his other enterprises. He scarcely realizes, yet, how wide and round the world is; how many of him there are working, and how his labor, ever to amount to anything, must not be done at cross purposes.

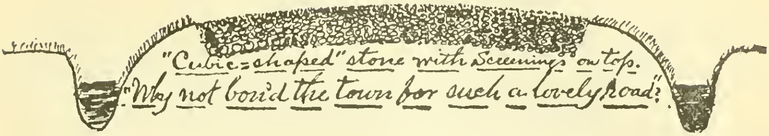
Mud on the top of stone is a common occurrence with ignorant and blundering "macadam," as is the throwing of retaining walls from the swelling of clay by frost. The next picture is no fancy sketch. It fairly represents parts of the "elevated" road between Hartford and East Hartford, Conn., and is equally a criticism on the engineering of either side or end of the Connecticut River: —


Clay-and-stone-wedge between weak walls.
MUD.
MUD
The space between these walls was filled with clay-loam from the adjoining meadows. This, expanded by frost, causes the walls to tumble and need constant rebuilding. M'Adam's roof-road is wanted here.

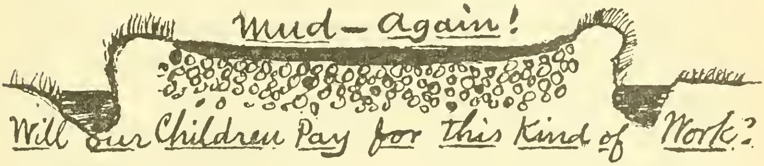
The above instance is fully noticed in "A Move for Better Roads" (H. C. Baird & Co., Philadelphia), pages 111 and 112, and a remedy is suggested: "In this case sand is cheap and convenient, while stone must be brought long distances. What else can we do but plant a rock crusher on that causeway, lift the stones and break them fine enough to fill their own crevices, bedding them solid and rain-tight on sand enough to keep the clay still?"

Coal ashes have been tried on that road since the quoted paragraph was written. Doubtless the trial was not thorough, for the mud continues to come up smiling in travellers' faces.

On long stretches of loamy land, hastily rounded up, without thorough drainage, to receive a coat of conventional "macadam," we see the same old foolishness working, as may be well shown in a couple of sketches, such as should appear on every common school black-board right away.

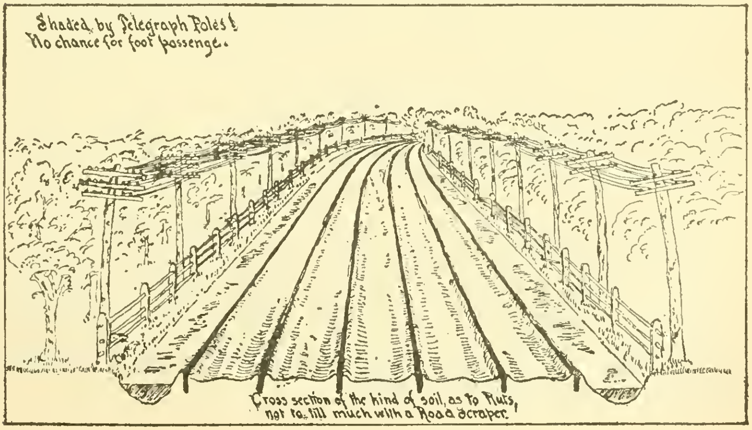

"Cubic-shaped" stone with Screenings on top.
"Why not bond the town for such a lovely road?"

The sequel — after a couple of freezing and thawing winters — is not so pleasant.


Mud — again!
Will our Children Pay for this Kind of Work?

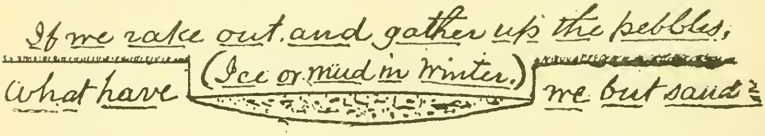
The too common "remedy" for the conditions above is to dump in more stone and dig out the gutters to throw on top. After awhile the stones will begin to ooze out with the mud of the gutters, and by a foolish public they can be used over and again.

Road scrapers would be more nearly adorable if once in awhile the men who run them did not destroy better footpaths than they make, and if they were not so fond of their scraping that they can't bear to leave a stretch of sandy road untouched, while they know well that flushing ruts with worn-out stuff, just fit for hens to dust in, only makes the poor-enough wheeling heavier. As we have seen three generations of the same family of road-menders, doing these naughty things, we put in a cartoon for their edification: —

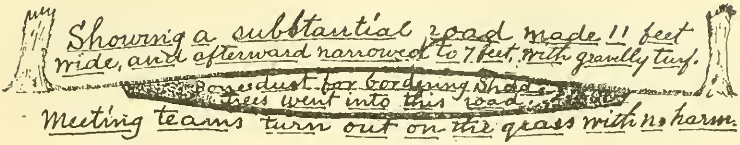

Shaded by Telegraph Poles!
No chance for foot passenge.
Cross section of the kind of soil, as to Ruts,
not to fill much with a Road scraper.

When once such soils are nicely graded, what is left then but sand, gutter-wash or muck for the scraper to bite at? Road scrapers work best where the soil bakes quickly in spring, and is hard, gravelly and stubborn; not where the ground can be stirred easily in any open month; there is the place for carting better road material. Forehanded and alert road-men used to keep two or three furrows of fresh soil or subsoil mellowing in the bottom or outside of gutters, to turn upon the highway after a month or two, and not bump themselves with tough sods in the road when they drove to meeting or market.

There is a great deal of private road iniquity. Promising children of smart parents — in lack of clean brooks to play in — are spoiled for being good road judges when they are quite small, by sailing boats during showery weather in the gutter walk, constantly ruined by the garden rake and water.



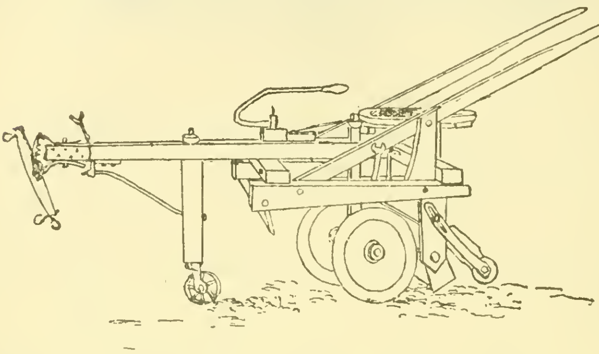
Ten two-horse loads of good foot-path or walk-gravel, of a red sandstone character, and *without pebbles*, were laid in the private road to the writer's door, three years ago, for experiment. The worn, sandy loam and subsoil the gravel was laid on is about as fine as snuff for twenty feet in depth. For more than two years this fine gravel refused to pack. A rain would settle it hard, but directly it would work up mealy again, and was the cause of much local criticism. During last summer this short strip of road was ballasted at different times, with no more than five or six barrow-loads of pebbles picked from the garden. The most of these were as small as English walnuts. Some were so large as to need breaking on the spot after they were spread, and all were precisely the kind of pebbles that are often raked up and shovelled away, with weeds and turf-trimmings, by ill-trained gardeners, to make piles of rubbish close to their composts. The road has since become hard and smooth, and the grass edges are growing into the gravel.


Showing a substantial road made 11 feet wide, and afterward narrowed to 7 feet, with gravelly turf.
Bones dust for bordering Shade-trees went into this road.
Meeting teams turn out on the grass with no harm.

Private roads and avenues of the "gutter-walk" pattern are out of place. In cities, with houses close together, gutter walks and roads may be unavoidable, and they should be paved; but in the country, where there is room enough, walks and roads should be raised and rounded. This prevents mud, dust and ice. Instead of being lower, their centres and entire breadth should be higher, than the bordering grass. In the best private work the edges of roads and walks will blend imperceptibly in grade with the turf, which should take the watershed of the travelled ways at once. It is precisely so with the finished country road. Highway means *high* way. If we relieve our gardeners and road makers from their mischievous use of the garden rake on our gravel ways, they will have more time to kill weeds and nourish grass. Where so much is to be done, misdirected labor is simply wicked.

In villages we suffer with dust, and handle too much worthless street mud. Except in crowded city thoroughfares, mud and dust might, with due knowledge of grass, be removed occasionally and nicely from rural and suburban gutters in the form of fine turf, and have the highest market value in that form. Instead of dusty and muddy street-fronts, adjoining residents might run their lawn-mowers on easy slopes quite to the verge of wheel tracks. We occasionally see neat and painstaking householders doing that already. We have only to be agreeable, and convene to make that a welcome fashion. Grass gutters shed water from the road. Mud does not.

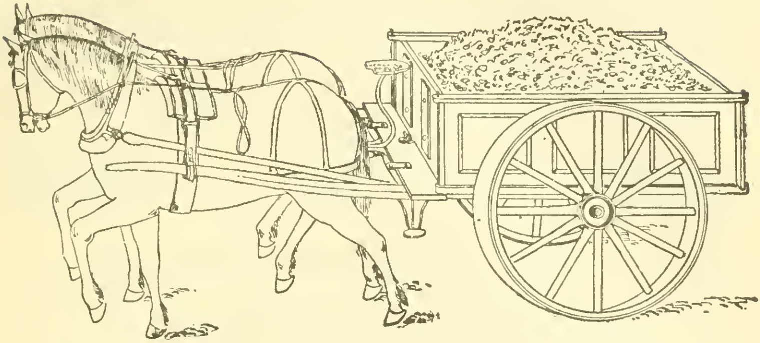
By the fine wash and occasional dust of ever so solid and narrow roads, bordering and gutter turf will gradually become too high from the continual accretion of fine material. To lift this turf handsomely and profitably turf-paring machines are needed. Perfect turf-cutters have been, can be and are made and sold. To enforce this idea, a contrivance of the writer's own — not the best — is introduced here. With the use of it he has cut, carted a mile and laid seventy-five two-horse loads of turf a day, at the cost of good loam.



Broad-tired carts for *making* roads need special attention here, because the road making fraternity looks coldly at the idea, since broad wheels may add to the cost of their outfit. The public will count the cost of rolling work with its carriages which the maker can't drive over, and the discerning public will estimate the value and service of roads which are built on narrow tires at their true worth,— generally nothing, oftener less than nothing.

But towns and private individuals, who are able and see their way clearly, can and have taken up broad cart wheels. so that they are being slowly introduced. They were always known in parts of New England. Many neaps of ox carts have been cut off, the wheels furnished with wide rims and tires, a pair of forward wheels and tongue added for horses. Possibly fifty of these double teams can be mustered within five miles of the writer's door.

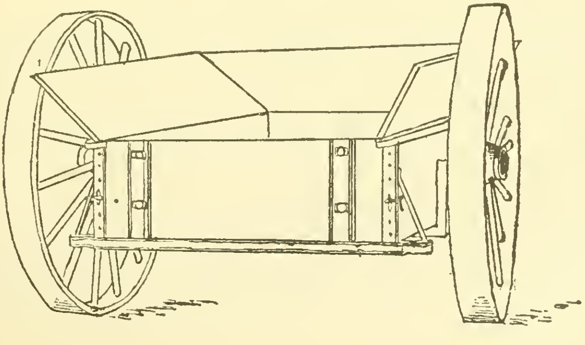
Ox carts are shorter and handier; but a still shorter rig for a pair of horses is shown here, as well worth our patronage, where much road and earth work is to be done. A one-horse cart is often too weak, and a four-wheeled dump awkward and cumbersome in a gravel or stone pit. A single-horse cart should have five-inch tires. Tires for two-horse or ox carts should be at least six inches wide.



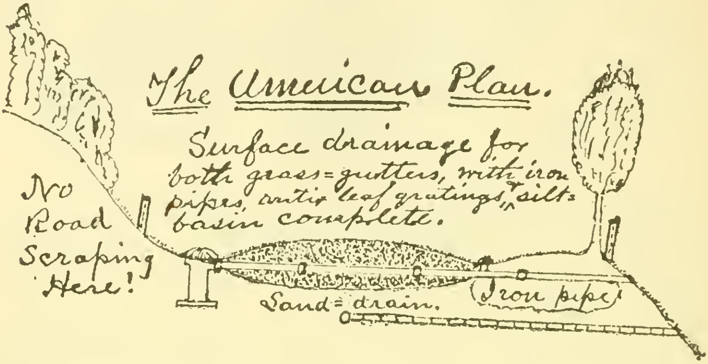
With all-leather harness, the writer has shifted two horses from single carts to the plough or scraper inside of three minutes. This change is often convenient in road repairs, or any grading of earth whatever.

At one time it is said fifty two-horse dumps, on single pairs of wheels, were in use in Canaan, Conn. With three shafts of tough, springy white oak, and all leather harness, discarding too heavy pads, the two-horse cart may be the shortest and most convenient strong road team in existence. Schools of design should proceed at once with fear and trembling to work out the details of this conception.

.The village cart, for one horse, sketched below, is built and used with satisfaction in South Manchester, Conn. The felloes and tires are five to six inches wide, and the axletree is bent to carry the body conveniently low for heavy or light loading. Flaring sideboards give capacity for strawy manure, leaves, etc.



Surface water in crossing finished roads of the best character and workmanship may be conducted from grass to grass without any washing at all. The following sketch shows this, which we may well call "The American Plan"—adapted to a side-hill: —


The American Plan.
Surface drainage for both grass=gutters, with iron pipes, anti-leaf gratings, & silt=basin complete.
No Road Scraping Here!
Sand=drain.
Iron pipe

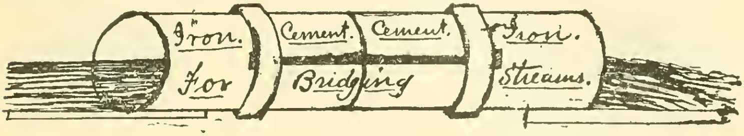
We have plenty of iron pipes for almost every other purpose, but nothing with connections fit for this business. Iron men and pattern makers should study these points at once.

It is a common thing to pay a hundred dollars for a stone culvert, where there is not room enough, so that a hillock is made in the road, or the culvert soon chokes with mud.

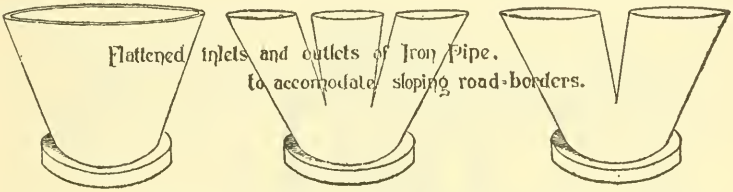
Flat gratings clog with sticks and leaves, and, when cut into a flat stone over brick silt-basins, they cost much trouble as well as money. If removed for any reason, the labor is lost; while, if we had several sizes of iron pipes and connections, the second-hand metal would be as good as new in some place. Cast iron doesn't rot.

It should be generally known that, for the surface drainage of sudden thaws, when the earth is covered with sposh, deep pipes in the frozen ground are good for nothing. They are too cold. Only cast iron pipe will endure being brought near the surface of a road where it can feel the warmth of the weather producing the thaw.

Many of our wooden bridges over small streams and rivulets might well be turned under the road in pipes of suitable size, arranged as follows. The lips or flanges of cast iron, both turned in, would hold them in place, if thoroughly packed in gravel, after the wrought iron bolts are rusted out.



For many culverts, inlets and outlets, flattened and divided to fit the slopes of the road, would be smoother and more comely, requiring less to be hidden by garden or wild shrubs.

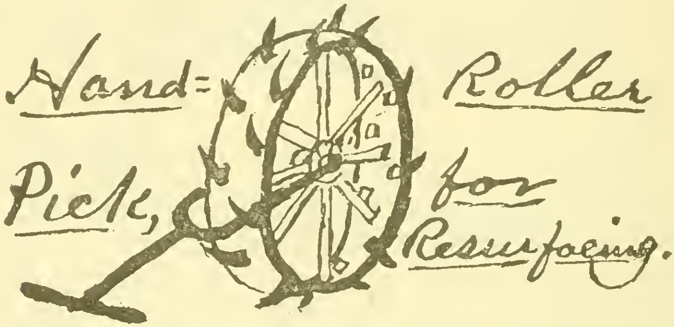

Flattened inlets and outlets of Iron Pipe.
to accomodate sloping road-borders.

The smaller sizes of these pipes would be much used in parks, cemeteries, private grounds and wherever it is understood that surface water causes more than half the expense of road repairs. Pipe-makers will do better to study the predicament our common roads are in, rather than these hasty sketches. The old iron lying unused about the country would furnish all the stock a founder would need to begin with.

We fail to realize how destitute the country is of special hand implements for road making. For their needs our sires were better provided with tools a hundred years ago. In the craze of railway building and wholesale machinery we have forgotten hand tools. Only a few years ago professional men — clergymen — were asking, "What has agriculture to do with road making?" The amateur road maker, in these days has to begin with his naked hands. The "amateur," by the way, is a person who does things for the *love* of doing them. The greatest names in history apply to those who did first what made them famous for the *love* of it. The professional is a hireling.

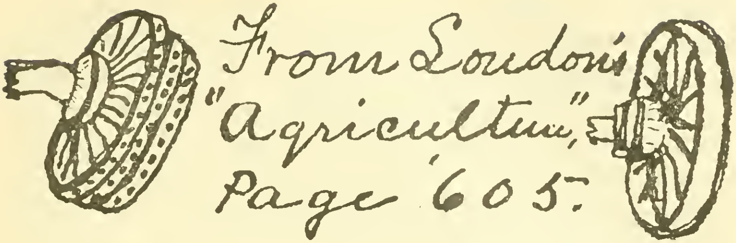
Mechanics who can design and make special road tools have gone from the country. Great machine shops refuse to touch new patterns unless ordered by the thousand dozen. Farmers supply themselves at each other's auctions, take the degenerate things in market, or go without. The best of that class of people mean to see their way clearly before going into anything. It is good for the nation that farmers move slowly and surely. Now we may be certain they are framing their minds for better hand road tools, to finish corners and edges of the roadside which machines can't touch. They are short of money, and must begin with their hands as was done in M'Adam's time.

A suggestion for a hand-roller-pick, to fit the surface of old stone-roads to receive new metal, is made here: —



Something like the above has been used in hard ditch bottoms. The same idea is applied on some steam rollers. It is to be rolled across the highway to break and roughen the hard old surface, or the road making hands may use pick-axes at intervals, while they are waiting for material.

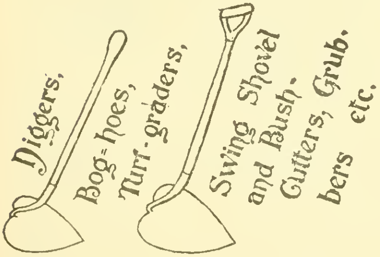
Writers have said that M'Adam was opposed to carts with broad tires. This is contrary to the truth. Before his time mechanic monstrosities were as possible as they are now. There were bounties by the inch on the width of cart-wheels, given in the form of exemption from tolls. Very heavy wagons were in use, and immense loads of freight were hauled to cheapen transportation on toll roads. Somebody contrived a curious conical wheel, sixteen inches wide, which M'Adam condemned before the committee of Parliament, because it was full of spike-heads, *dragged* on the shortest side, and injured the roads.

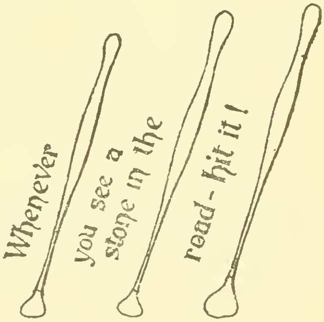


From Loudon's "Agriculture," Page 605.

M'Adam hated the absurd and conical wheel manufactured by the greedy transportation companies of his time, but approved the flat tread of the other. It is always well to range from landmarks in the past to see how we are getting on.

Here we bring in some small, special road tools: a new digging-hoe with knob or "D" handle, that, if well made,—so universal is its application,—would sell at sight in China, or any part of the world. With it strong and expert men can fill fifty to one hundred cart-loads of rooty earth in a day.



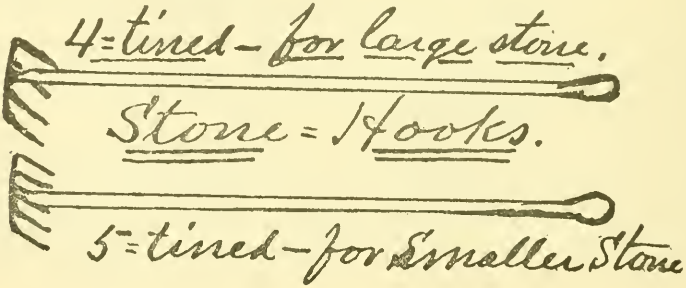


"Why don't farmers clean up their roadsides?" is often asked. What tools have they—for instance—for trimming to a feather-edge, the abrupt banks gouged by "the bullet-headed road-mender" in front of their bar-ways and doors? Will the spade, or the round-point, or broad mouthed shovel do it? Try them, and see.

Are our agricultural schools and experiment stations combining to study out and patronize better hand tools, to the end that the country may be better equipped? Not much. They are willing to "test" the tools in the market whenever they are presented to them; but, as for original investigations of hand tools for road making or agriculture generally, with few exceptions it is believed they are giving more patronage to factories of fire-arms, fish-rods, weedy lawn-tennis and base-ball equipments. Of course we expect much good from the more generous culture of our youth in out-of-door sports; but why not, with fit and even elegantly fit tools for hand labor, let the good come right along? We need it *now!*

Some cities have discovered that tramps will break stone nicely on the road when furnished with lithe hammer handles as long as billiard cues. Whip-handle hammers — metal flat-turnip form, of layer wrought, or *cast* cast steel — will commend themselves, whenever seen and used, for making and maintaining solid and smooth roads. The knob-handle, working in the palm of the hand like the pully in the belt,— another ball-and-socket joint to the fore-arm, — is half the battle with the labor of cracking stone. The ordinary mechanic's hammer, cut with two faces from bar steel, is fit for the anvil and work bench; but a steel swingel and flail-staff would be more fit for striking blows on the road. The ordinary broad, flat hammer handle of the mechanic, when made long enough to enable a man to stand upright and reach the road, strains and cramps the muscles of the hand and wrist intolerably. The great cause of poverty and misery is that we have few or no hand tools for the land which laboring people would be proud to own. Labor is much shrewder than we think.

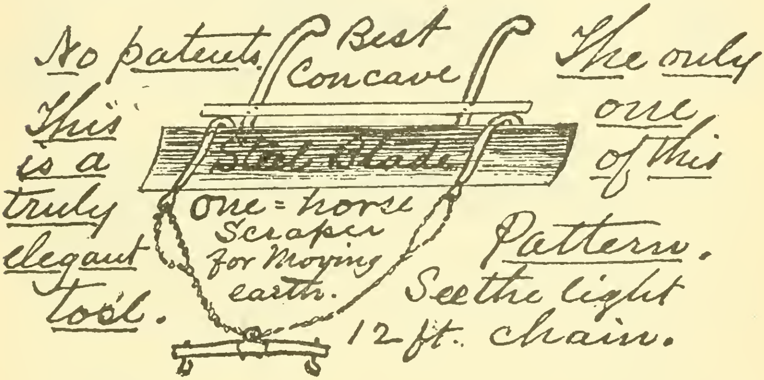
Here are pull-forks with knob-handles, for overhauling and assorting stone and gravel, dumped above grade on the head of the fill in road making. These are indispensable for solid, smooth-wearing and durable gravel-work: —


4=tined—for large stone.
Stone=Hooks.
5=tined—for smaller Stone

The tines of a select manure-hook can be cut off and sharpened so as to fairly represent the four-tined implement,—*minus the knob-hilt.* A road maker needs a grip for his tools as much as a soldier does.

The five-tined hook is larger than a potato-hook, and in these declining, or let us hope, *gaining* days of home industry, can best be got by bending the five tines of a long-handled manure-fork,—if we can find a smith who can spring-temper the tines again.

A one-horse scraper is introduced here that is undoubtedly the keenest grading implement in the world for moving mellow earth short distances.*


Best Concave
Steel Blade
One-horse Scraper for Moving earth.

No patents.

This is a truly elegant tool.

The only one of this Pattern.

See the light 12-ft. chain.

Stone or gravel road of the best possible quality will wear and wear out by constant friction, especially on hill-roads, where water greatly aggravates the picking of horse-shoes in toe-paths, and the tendency of wheels and heedless drivers to make ruts. Every good stone man should hold to the idea of having hill-roads *shod* and *anchored* across them, with hard-stone curbing, in an angular form, to act as water bars also, set fast just beneath the surface of the flush broken stone or gravel. These curbs may be put in ten to thirty feet apart, as may be necessary, and will be as useful on hill-roads as the steel toe of a horse-shoe is injurious,—producing the happy balance we are all seeking.

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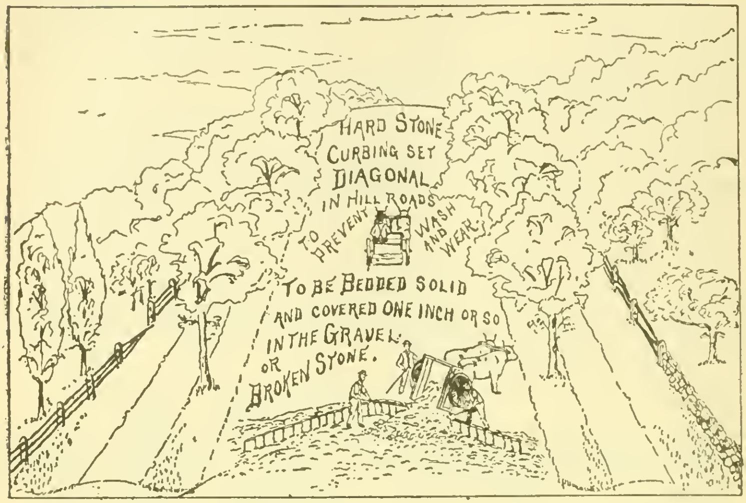
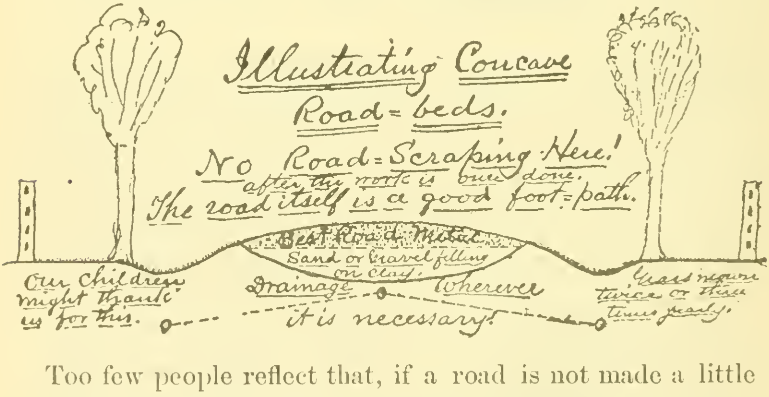
* Thanks to Geo. W. Taft of Kennett Square, Pa.


HARD STONE CURBING SET DIAGONAL IN HILL ROADS
TO PREVENT WASH AND WEAR.
TO BE BEDDED SOLID AND COVERED ONE INCH OR SO IN THE GRAVEL OR BROKEN STONE.

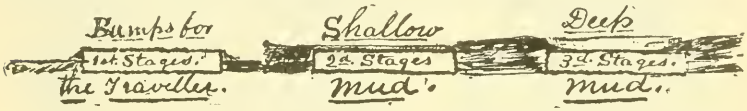
Here are suggestions for the form of a highway through flat, arable plains and pastures, or clay meadows. This road, too, requires no repairs but fine broken stone, as may be needed to replace the loss to the surface by friction, wind and water. In preparing concave road-beds, the best wheel scrapers may be of the greatest use in skilled hands.


Illustrating Concave Road=beds.
No Road=Scraping Here! after the work is once done.
The road itself is a good foot=path.
Best Road Metal.
Sand or Gravel filling on clay.
Our children might thank us for this.
Drainage wherever it is necessary!
Grass require twice or three times yearly.

Too few people reflect that, if a road is not made a little too high, it will be too low when it is used awhile. A very durable road must be shod for wear, something like a double-soled shoe. Earthen roads rapidly wash and blow away, and even the best new stone work will settle some. M'Adam's "roof" roads and "floors" will be water-tight, because the broken stone is so close as to shed its own superfluous silt, and even the droppings of horses with the water of rains. The road must "clean itself," as Telford said. There ought to be material for several years' friction on top of the perfection of a good country road, and thoughtful people must agree to that or roads will be made half worn-out to begin with. Society has other urgent cares, and can't be always making temporary roads.

A simple method of constructing an excellent cross-walk of very pebbly gravel, or small crushed rock, over stone, gravel or earth roads, is shown here, because it is often cheaper and much easier to get done than stone pavement; less likely to jolt vehicles, and can be built or amended by the road maker or private parties.

Let us first sketch the way broad slabs of granite are apt to work in a muddy street, when the women folks have dunned the men long enough to get them laid: —

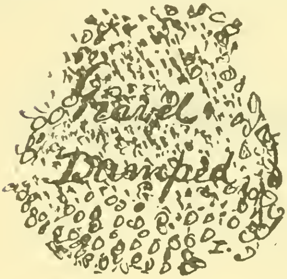


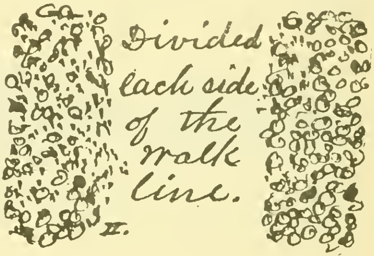
First, the slab of granite settles a little under the banging it gets from teams, but no census reporter tells how many millions of jolted people, broken eggs, wagon springs, and commandments are spent on those abrupt corners, which are most felt in the stomach when they strike the traveller unawares in a muddy time. Nothing rounds them, however, but horse shoes, wheels and sleigh runners, — a slow process. And, when the road is next mended, the slabs are buried with care, which brings us to the second and "shallow mud" stage of the cross walk. Having experienced those slabs itself, the village improvement society is slow to raise them again, and the road-mender, made and provided, is not the man to have crow-bars, water-level, stone chisels, hammers, and loads of sand with him when he is mending roads, to raise those slabs above grade, and knock the corners off. So the next time he comes along he raises the road and leaves the cross walk in the third and "deep-mud stages."

It is but fair to add that two or three parallel slabs of granite, a foot wide, with foot intervals of pebble pavement, can be laid well bedded with coarse sand or fine gravel, and slightly rounding in a cross walk, so as to be much less objectionable to through travel than broad stone flags.

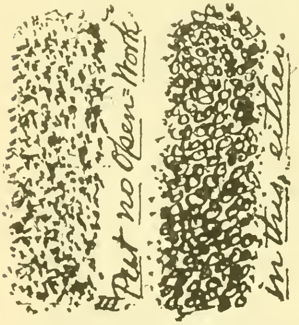
In cities, feather edges of asphalt and coal tar supersede rough stone and foolish brick, as nice gravel shames slovenly earth in the country.

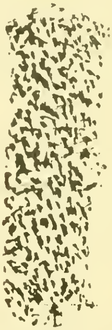
As a primary lesson in road making, the cross walk of gravel or broken stone is worth describing in detail. The same method can be adapted to water bars, angular, or otherwise. Let the gravel or broken stone for the cross walk be dumped in place across the road, and then divided into two continuous and equal lines, two or three feet apart, each side of the centre of the proposed walk. We sketch these two operations at one end in a pair of home-made views.

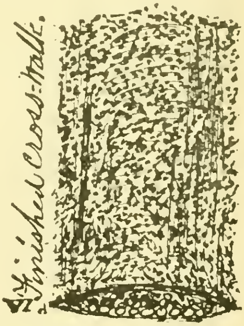




Now, with a potato-hook or close-tined manure-fork, comb all the larger pebbles or stones into the middle space, in slightly rotund shape, and well filled with fine material to form the backbone of the walk, leaving enough stoneless gravel to grade and cover the whole nicely.







The new work can be wet with a watering-pot, and rolled with a broad-tired wheelbarrow. The gravel cross walk, with a backbone in it, can be perpetuated by the road-mender, if fit for his place and he knows how to win votes with his work.

The following sectional views are taken from the Harrisburg steam roller circular. They show how prevalent the notion of *porous* stone and road work is. It directs that "No binding must go on the foundation course, as *it is necessary to be porous*, so that *water will readily pass through*, and for this reason excessive rolling must be avoided at this stage." The italics are ours.

Fig. 1

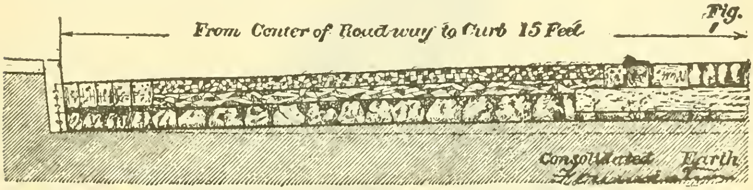

From Center of Roadway to Curb 15 Feet
Consolidated Earth
Foundation

Fig. 2

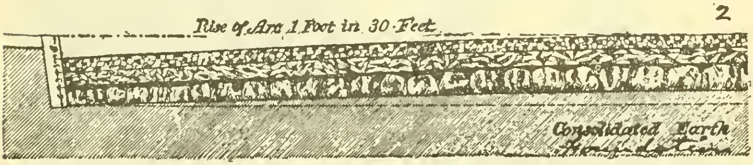
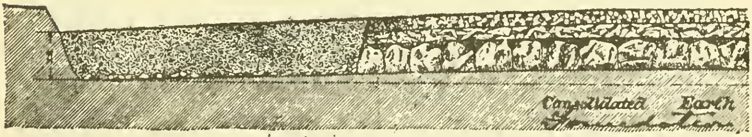

Rise of Arc 1 Foot in 30 Feet
Consolidated Earth
Foundation

Fig. 3

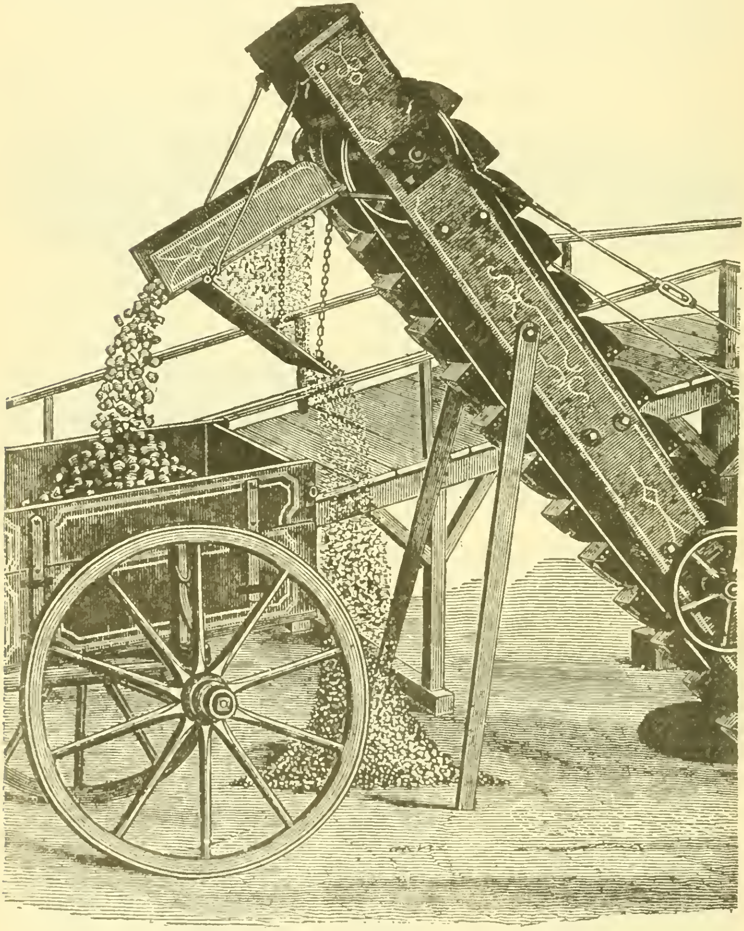

Consolidated Earth
Foundation

Half = CROSS-SECTIONS OF T
Telford Road-way.

No farmer who is a builder would accept a section of this "porous" stone work, twelve to fifteen inches deep, as a foundation for the sill of a hog pen. How much more quickly should we reject that kind of foundation for the twisting pressure of loaded wagon wheels?

Jack Frost will laugh at the fool-mortals who trust to "consolidated earth" only twelve to fifteen inches below porous stone-work, through which water leaches to saturate the clay.

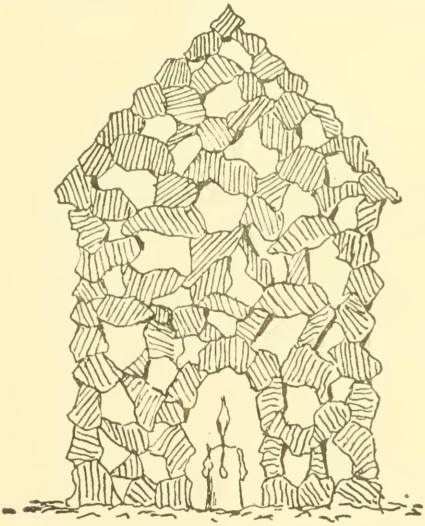
It may seem ungracious to make extracts from these too eager and selfish teachers of the people. But, when caught in the act by their own forward testimony, what other remedy have we? This cut is from circular of Gates Crusher, Chicago: —



Here at the quarry and the crusher seems to be the source of the organic porosity which destroys bogus "macadam." Here we see the prairie farmer loaded with sink-in-the-mud stone, while pure-grit filling is reserved for some fellow who will pay more money. That is railway ballast left loose for knocking out ties at all seasons. Massachusetts is stuffed with the same false doctrine. Cheating and competing quarries and public workmen saw, when contracts and piecework for roads were suggested, that clay would swallow more broken stones if they were furnished in assorted sizes, and also that the stone would measure more. When will the general public see? Then we shall begin to have better stone-roads.

The gist of this whole matter can be written in a single sentence, as follows: HOW CAN A STONE RAFT FLOAT ON A SEA OF MUD IF WE BUILD IT LEAKY?

In very common and much mistaken schools it may be necessary to set up a broken stone lantern to throw light upon our subject, in this way: —



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SPECIAL REPORT

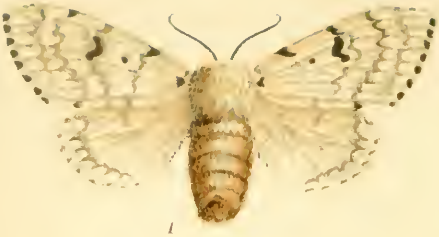
OF THE

STATE BOARD OF AGRICULTURE

ON THE WORK OF

EXTERMINATION OF THE OCNERIA DISPAR OR GYPSY MOTH.

PLATE I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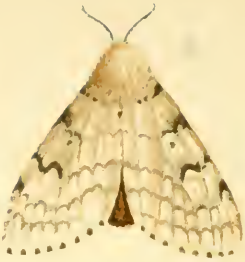
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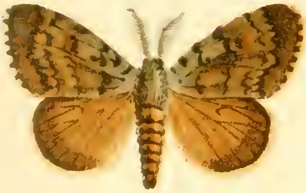
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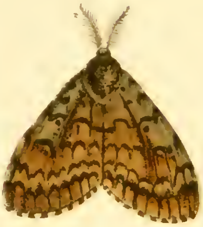
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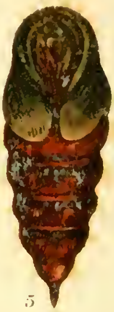
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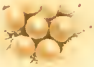
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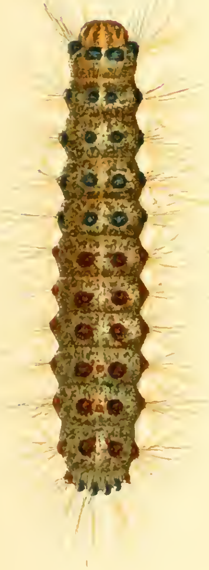
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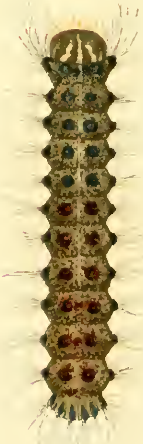
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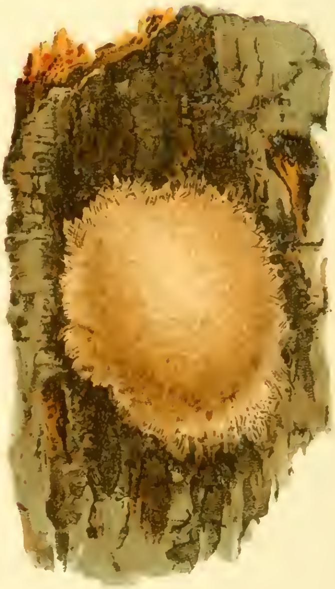
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Drawn by Joseph Bridgham

Heliotype Printing Co. Boston

GYPSY MOTH

EXPLANATION OF PLATE I.

GYPSY MOTH (Ocneria dispar, L.)

Fig. 1.—Female with the wings spread.
2.—Female with the wings folded.
3.—Male with the wings spread.
4.—Male with the wings folded.
5.—Pupa.
6.—Caterpillar. } Full grown.
7.—Caterpillar. }
8.—Cluster of eggs on bark.
9.—Several eggs enlarged.
10.—One egg greatly enlarged.

THE GYPSY MOTH.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

The State Board of Agriculture, in accordance with the provisions of chapter 210, Acts of 1891, presents its report of transactions and expenditures.

As the Board is by law made the successor of the Gypsy Moth Commission, it seems proper that an allusion should be made to the original commission, the appointment of the second commission, and the method of transfer to this Board. By an act approved March 14, 1890, the Governor was "authorized to appoint a commission to provide and carry into execution all possible and reasonable measures to prevent the spreading and secure the extermination of the Ocneria dispar or gypsy moth, in this Commonwealth." By the same act twenty-five thousand dollars was provided for the work. Under this act three commissioners were appointed, and commenced work about April 1, 1890. The Legislature made an additional appropriation of twenty-five thousand dollars, which was approved June 3, 1890.

These commissioners continued in office until Feb. 15, 1891. On March 4, 1891, N. S. Shaler and Francis H. Appleton, members of the Board of Agriculture, and Wm. R. Sessions, secretary of said Board, were appointed commissioners. The new commission organized and acted as such until it was superseded by the Board of Agriculture. Chapter 210, Acts of 1891, was approved April 17, 1891. This act placed the work in the hands of the State Board of Agriculture, with all the powers and duties which previous legislation had conferred upon the commissioners, and also provided that "All moneys heretofore appropriated and authorized to be expended . . . and not heretofore expended are hereby appropriated and authorized to be expended by said Board in carrying out the purposes of this act." It also provided that "All the property acquired, and records kept under provisions of said chapter 95 of the Acts of the year 1890 shall be delivered into the custody of said Board, and said Board is authorized to take, receive and use the same for the purposes of this act." Section 8 of chapter 210, Acts of 1891, provided that "The said State Board of Agriculture may exercise all the duties and powers herein conferred upon said Board by and through its secretary and such members of said Board as it may designate and appoint to have in charge, in conjunction with its secretary, the execution of the purposes of this act."

At a meeting of the Board of Agriculture, April 28, 1891, called for that purpose, Wm. R. Sessions, N. S. Shaler and Francis H. Appleton were chosen "a committee with full powers to exercise all the duties and powers conferred upon the Board of Agriculture by an act to provide against the depredations of the insect known as the Ocneria dispar or gypsy moth, known as House Bill No. 228." Thus the same men who had since March 4th acted as a commission in the gypsy moth work were appointed under the law to act for the Board of Agriculture. As a consequence, the work of the Board carried on by the committee was a continuation of the work of the commission, and therefore it is necessary that the work of the second commission should be noticed as preliminary to the report of the work of this Board. By enquiring of the auditor, it was ascertained that there was remaining unexpended of the appropriation of last year $24,460.68. This sum was available for the work of the commission.

The members of the first commission were consulted. They gave the new commission such information as they had obtained as to the extent of territory infested, the method pursued by them in their last season's work, and turned over the property and records. Prof. C. V. Riley, entomologist of the United States Department of Agriculture, Prof. C. H. Fernald of the Agricultural College, Prof. Samuel Henshaw of the Boston Natural History Society, and Prof. S. H. Scudder of Cambridge, expert entomologists, were invited to meet with the commission and consider the conditions and the work to be done, and give advice as entomologists. They all accepted the invitation, and met with the commissioners early in March. Their opinions and advice were asked and freely given. The mayors of cities and chairmen of selectmen of towns in the infested territory were also invited to be present at the meeting. Most of these officers were present. Their opinions on the situation and conditions in their several localities were secured by the commission.

Mr. E. H. Forbush of Worcester was appointed director of field work, March 12, 1891. Mr. Forbush is a naturalist of reputation and experience. He had been for several years president and managing director of the Worcester Natural History Society, and president of the Worcester Summer School of Natural History. The commission was obliged to secure his release from an engagement for scientific work in order to obtain his services.

Efforts were immediately made by the director and commission to procure suitable men for the work. Several were engaged from among the students of the Agricultural College, and most of them proved to be efficient and valuable assistants. The force was increased as suitable men could be obtained, and the surrounding country was carefully examined for the eggs of the moth, to the end that the extent of the infested territory might be known with certainty. It was found that the insect had secured a foothold in twenty cities and towns, and that Medford, Malden, Everett and parts of Somerville, Arlington, Melrose and Cambridge were thoroughly infested. When the caterpillars appeared, spraying was commenced with a large force of men and teams equipped with hogsheads of Paris green and water, pumps, hose, ladders, oil suits, etc., — an extensive and expensive outfit.

Meantime, chapter 210, Acts of 1891, had become a law; and the committee of the Board of Agriculture above named organized on May 19, 1891, by choosing Wm. R. Sessions, chairman and secretary, and assumed control in the name of and for the State Board of Agriculture. The sum of $11,003.22 only remained of the previous appropriations. The appointment of E. H. Forbush as director of field work by the commission was confirmed and continued by the committee, and the plans formed by the commission were also approved and adopted, and the committee directed that the work in progress should be continued. To prevent the transportation of caterpillars by teams, a large force of police was employed to guard the roads leading from the infested territory; but it was found impossible to make their work effective, and other means were resorted to to overcome the danger of spreading by transportation.

A code of rules and regulations was adopted, a copy of which is appended to this report. On June 3rd an additional appropriation of $50,000 for the work was made by the Legislature. The force was immediately increased, and the work of spraying pushed with all possible rapidity. More than thirty teams and not less than two hundred and thirty men were employed. This work was continued until the caterpillars had so far ceased to feed that the spraying had little effect upon them. Vast numbers were destroyed by the spraying; but, from the fact that they were hatching all through the season, and the larvæ in all stages of growth were present at the same time and also that many had changed into the pupa stage before the latest hatching had been completed, it was found that spraying could not be depended on to kill them all. Their habit of spinning down when disturbed, and crawling away into the grass or other concealed situations, also prevents complete destruction by spraying.

On June 18th, Prof. Chas. H. Fernald of the Massachusetts Agricultural College was appointed entomological adviser to the committee, and was requested to at once critically examine the field work of the committee, and make a written report thereon, with suggestions and advice for the future. This was done by the professor, and since then he has from time to time visited the infested territory and inspected the work, directing experiments and advising as to the work in progress, and making a written report of each visit. At the suggestion of Professor Fernald the director and all the force were directed to watch for parasites preying upon the insect in its various stages. As a result, several such parasites were discovered. Professor Fernald advised that these native parasites be observed and experimented with before incurring the expense of importing others from Europe, the indications being that the natives might be able to render all the assistance that could be expected from parasites.

When spraying ceased, every effort was made to destroy the creatures during the short time they remained in the pupa and moth stages. The men were then set to gathering and destroying eggs. It was found that in the section where they were most plentiful in the spring there were comparatively few, not more than one-tenth the number there were last spring. An effort was made to go systematically over the entire territory, gathering the eggs; but, as only the most trustworthy men, who were also careful observers, could be relied upon to do the work, it was necessary to reduce the force by discharging all others. The progress was necessarily slow, as every tree, shrub, wall, fence, pig-pen, hen-house, shed, and even houses and barns, in the most thickly infested territory had to be carefully examined by the men, and afterwards inspected by the most expert among them. In doing this work use was made of every possible method to save time and expense. Old stone walls were burned out by the use of crude petroleum. The oil was forced among the stones in the form of a spray, by the use of pumps and spraying nozzles. Large tracts of land covered with brush were burned over after the brush had been cut and sprayed with petroleum, and in some cases woodland was cut and burned over after the wood worth saving had been examined and removed. The task undertaken proved a costly one, and it was found that the appropriation made by the last Legislature would be insufficient to complete the work. The committee believed that they ought to be able to inform the Legislature with certainty as to the extent of territory which had been invaded by the moth. So, about the 20th of November, the leaves having fallen, the whole force was put to work carefully inspecting the towns surrounding the territory in which the moth was found at the time of the spring inspection. This work has just been completed. The eggs of the moth were found in a very few places outside of the territory where it was found in the spring, but in no such case were they found in any considerable numbers.

The committee believes that the work of gathering the eggs throughout the entire district infested should be completed in the most thorough manner before the appearance of the leaves next spring. If this can be accomplished, we believe that the number of caterpillars that will appear in the spring will be comparatively small, and that they will be so much scattered that they can be found and destroyed without the spraying of the trees and shrubs of the whole country. The work of spraying is very expensive, and many owners of property are much opposed to having it done on their premises. If this systematic egg-gathering is to be completed as above recommended, a large force of sharp and reliable men must be set at work at once. The appropriations granted by the last Legislature are almost exhausted, and this work cannot be begun until the present Legislature provides the means. With prompt and liberal provision for the next season's work the committee believes that decided progress can be made in the task Massachusetts has undertaken, to wit, "To prevent the spreading and to secure the extermination of the Ocneria dispar or gypsy moth in this Commonwealth."

The committee believes that an appropriation of seventy-five thousand dollars will be needed to carry on the work according to the plans laid out for 1892. For details of the work of the past season we beg to refer you to the reports of Prof. C. H. Fernald, entomological adviser of the committee, and of Mr. E. H. Forbush, director of the field work, which are transmitted with this report.

The following is a statement of the expenditures of the Board of Agriculture by their committee.

WM. R. SESSIONS,
Secretary of the Board of Agriculture.

FINANCIAL STATEMENT — 1891.

1891.			
January 1.	Amount on hand,	$24,460 68	
	Amount expended by old commission,		$630 95
	Balance,		23,829 73
April 1.	Balance on hand,	$23,829 73	
	Amount expended by new commission,		12,826 51
	Balance,		11,003 22
		$23,829 73	$23,829 73
May 19.	Balance on hand,	$11,003 22	
	Appropriation,	50,000 00	
	Expenditures by the State Board of Agriculture:		
	Wm. R. Sessions, expenses,		$22 28
	N. S. Shaler, expenses,		74 25
	Francis H. Appleton, expenses,		25 00
	E. H. Forbush, director,		1,500 00
	C. H. Fernald, entomologist, remuneration and expenses,		280 84
	Assistant entomologist and microscopist,		595 08
	Book-keeper,		504 62
	Purchase of horse, buggy, etc.,		291 25
	Legal expenses,		50 00
	Travelling expenses of inspectors and men,		840 14
	Insecticides,		1,108 12
	Teaming, etc.,		5,252 93
	Wages of men,		39,997 16
	Supplies and tools,		5,248 42
	Balance,	$61,003 22	55,790 09

TOTAL AMOUNT EXPENDED IN 1891.

Old commission,	$630 95
New commission,	12,826 51
Board of Agriculture,	55,790 09
Total,	$69,247 55

Rules and Regulations of the Gypsy Moth Committee.

1. All persons are forbidden by law to remove the gypsy moth, its nests or eggs, from one place to another, in any city or town, and are requested to exercise care against so transporting the gypsy moth on teams and carriages.

2. All persons are forbidden to remove from the present locality in the towns of Medford, Everett, Chelsea, Malden, Melrose and Arlington, any hay, manure, wood, bark, trees, rags, lumber or shrubbery of any kind, without a written permit from the department. All loads must be well covered with canvas covers.

3. All persons are forbidden to in any way imitate or erase the marks employed by this department to designate trees, fences or buildings, which are infested or have been cleaned.

4. All vehicles leaving the above-named district may be stopped by the officers of the department, and delayed until their contents have been sufficiently inspected to determine the fact that they are not liable to transmit the eggs or any other form of the insect.

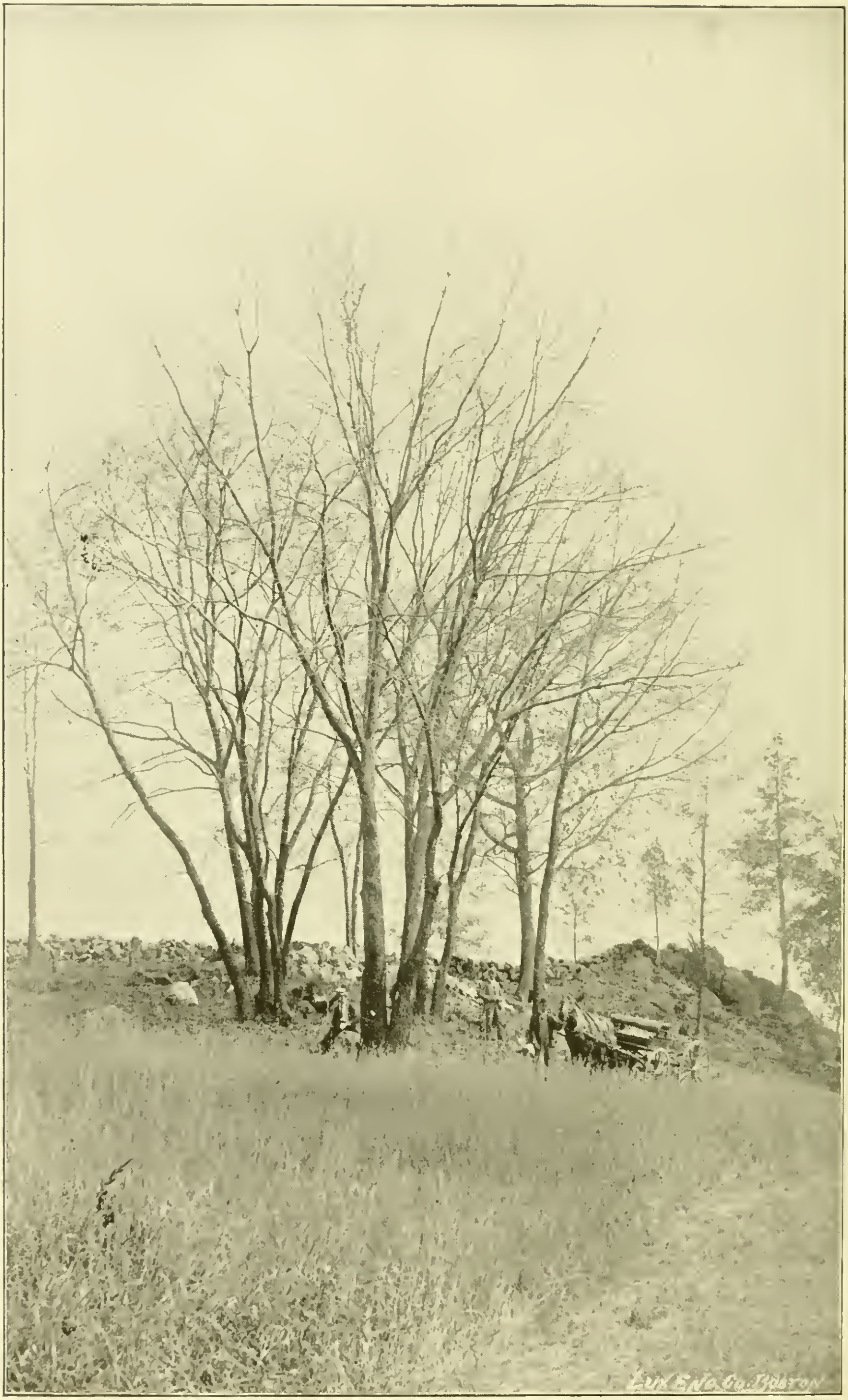
5. No person shall remove the bark from trees, nor attempt to scrape and clean them, without first notifying this department, and having said trees thoroughly inspected, and, if found infested, cleaned under its direction. The eggs of the gypsy moth are frequently scattered abroad by scraping the trees and by careless gathering; therefore, all persons except the authorized agents of this department are forbidden to remove the eggs of the gypsy moth from trees or other objects upon which they may have been deposited. Real estate owners and tenants are requested to destroy *all other forms* of the moth which they may find upon their premises.

6. All persons, upon notice, are required to confine their dogs while the agents of this department are at work upon their premises.

7. Owners or tenants are requested to gather and burn all rubbish and useless material upon their premises that may provide nesting places for the insect, and to fill with cement or other solid material all holes in trees upon their premises.

8. All persons are requested to keep the windows of their houses protected by screens during the summer months, as it is found the insect often lays its eggs in the houses, wherever it can gain admittance.

9. All persons having reasonable cause to believe that the eggs, caterpillars or other forms of the gypsy moth exist on or about


Lux Eng. Co. Boston

Trees stripped by caterpillars of the Gypsy Moth.

ARLINGTON, MASS., JULY 9, 1891.

their premises, are earnestly requested to forthwith notify E. H. Forbush, director, by letter addressed to his office in Malden, Mass. Information of their existence in isolated or unexpected localities will be gratefully received, and all persons furnishing such information will receive the thanks of the department.

10. Notice is hereby given that it will, in some cases, be necessary to remove boards from fences or buildings. In all cases they will be eventually replaced, if possible, without damage to the structure. Attention is called to the fact that any damage done by the agents or servants of this department, in the work of exterminating the moth, may be recovered under provisions of section 2, chapter 210, Acts of 1891. Attention is also called to section 6 of said act, which sets forth the penalties for obstructing any servant or agent of the State Board of Agriculture under this Act.

11. Courteous and considerate conduct is expected of all agents and employees of the department. Complaints in writing concerning any infraction of this rule should be sent to the director, and will be heard by him or the Committee.

Wm. R. Sessions,
N. S. Shaler,
Francis H. Appleton,
Committee of State Board of Agriculture.

Field Director's Report.

To the Committee on the Gypsy Moth.

Gentlemen: Your director of field work was appointed March 12, 1891. The next day he went to Amherst, and there engaged nine students of the Massachusetts Agricultural College to act as inspectors. These young men were highly recommended by the president and faculty of the college, and were selected on account of their fitness for the work. The next step was a consultation with Prof. C. H. Fernald of the Hatch Experiment Station at Amherst, entomologist of the State Board of Agriculture. It was largely upon his recommendation that several of the best men were employed, and from that time on his advice and assistance were always freely sought and as freely given. The plans of the director were from time to time perfected by a careful consideration of his recommendations.

In the meantime an office was opened, and measures were taken to secure workmen. The district then known to be infested was hastily inspected by the director. Maps were secured and divided into sections, and a plan of action was made. The men arrived at the office of the State Board of Agriculture on Thursday, March 19, received instructions, and then went to Malden. On Friday, March 20, sixteen men were in the field.

Organization. — Beginning of Section Work.

It was at once seen that the work of crushing out the species would be an arduous task. For an undertaking of this character and magnitude, men were needed who by nature and training were fitted for the work. A perfect system was imperative. An intimate acquaintance with the country must be acquired. An accurate knowledge of the habits of the insect was a necessity, and constant vigilance an indispensable requisite.

When field operations were commenced, the eggs of the gypsy moth were the only living form of the pest. The men were carefully trained to recognize and destroy them, and to distinguish between their eggs and those of our native moths. They were taught to observe all evidences of the existence of the gypsy moth, and were requested to secure all information possible in regard to its habits. Each inspector was instructed to make out a daily written report of the work done by himself and his men, and to include in this report his observations on the habits of the insect. Many valuable facts were thus recorded during the season. As the force was organized, each inspector was given a squad of men, and a section, indicated by a map, was allotted him, with instructions to inspect it, and destroy the eggs therein. When eggs were found upon a tree, the tree was marked with white paint and the locality designated upon the map. Special implements for the work were invented as necessity required, and a stock of equipments and material was gradually accumulated.

At this time the gypsy moth was supposed to be confined to eight or nine towns. Inspectors were sent out to determine how far it had extended, and soon found small colonies in other towns. It was at once evident that inspection must be continued until the limits of the infested district were determined. This method was followed until the new leaves covering the trees rendered further inspection impracticable. The work was resumed when the caterpillars had nearly reached maturity, was continued after the leaves fell, and is still in progress.

After the men had received the training and experience without which their work would have been of little value, there remained but six weeks in which to make a hasty inspection of the territory and destroy the eggs. Although the work was thus necessarily hurried and imperfect, yet, in consequence of it, the insects have not since appeared in more than sixty localities where the eggs were found in the spring. The infested towns farthest from the centre were first visited by the men engaged in destroying eggs. The men worked from these towns toward Malden and Medford. Before this work was completed the eggs began to hatch. This rendered thorough work an impossibility. No attempt was made, therefore, in the spring, to complete this work in Malden and Medford, except upon trees on or near the highways.

Cutting and Burning.

Wherever worthless, hollow trees were found infested, they were felled and burned. More than one hundred acres of brush and woodland have been burned over, and everything upon it destroyed. Stone walls in which eggs were laid were thoroughly cleaned by fire. In this way vast numbers of moths and their eggs were destroyed during the season.

Banding Trees.

As it was observed early in the campaign that the distribution of the caterpillars was effected largely by their falling from the trees upon teams, an effort was made to destroy all eggs upon trees on or near the highways. Before the hatching of the eggs, many of the large street trees in Malden, most of those in Medford and some in Somerville, were banded with strips of tarred paper. This work was first undertaken in Medford. It was proposed by the selectmen of that town as a means of protecting the street trees from the gypsy moth and the canker worm. It proved a very effective means of preventing the depredations of each of these species. The town furnished the labor and paper for banding the trees in Medford. These strips were kept moist by regular applications of a mixture that the caterpillars could not cross. Great numbers of eggs had been deposited on buildings, fences and other objects near the trees. As soon as the young caterpillars left the eggs, instinct led them to the trees, and, as they crawled upward to find food, many were entangled in the cotton waste under the tarred paper and perished. Many more succeeded in getting upon the paper, and, in cases where they were very numerous, would undoubtedly have bridged the mixture upon the paper with their bodies, until some had passed over. The men employed in applying the mixture from day to day prevented this by killing them with their brushes. Some eggs in the trees which had been missed in the spring doubtless hatched, but most of the caterpillars descended from the tree at one time or another, and were unable to return. This greatly reduced the danger that had seemed imminent in tne spring, — that the caterpillars would be distributed in large numbers.

Experimental Work.

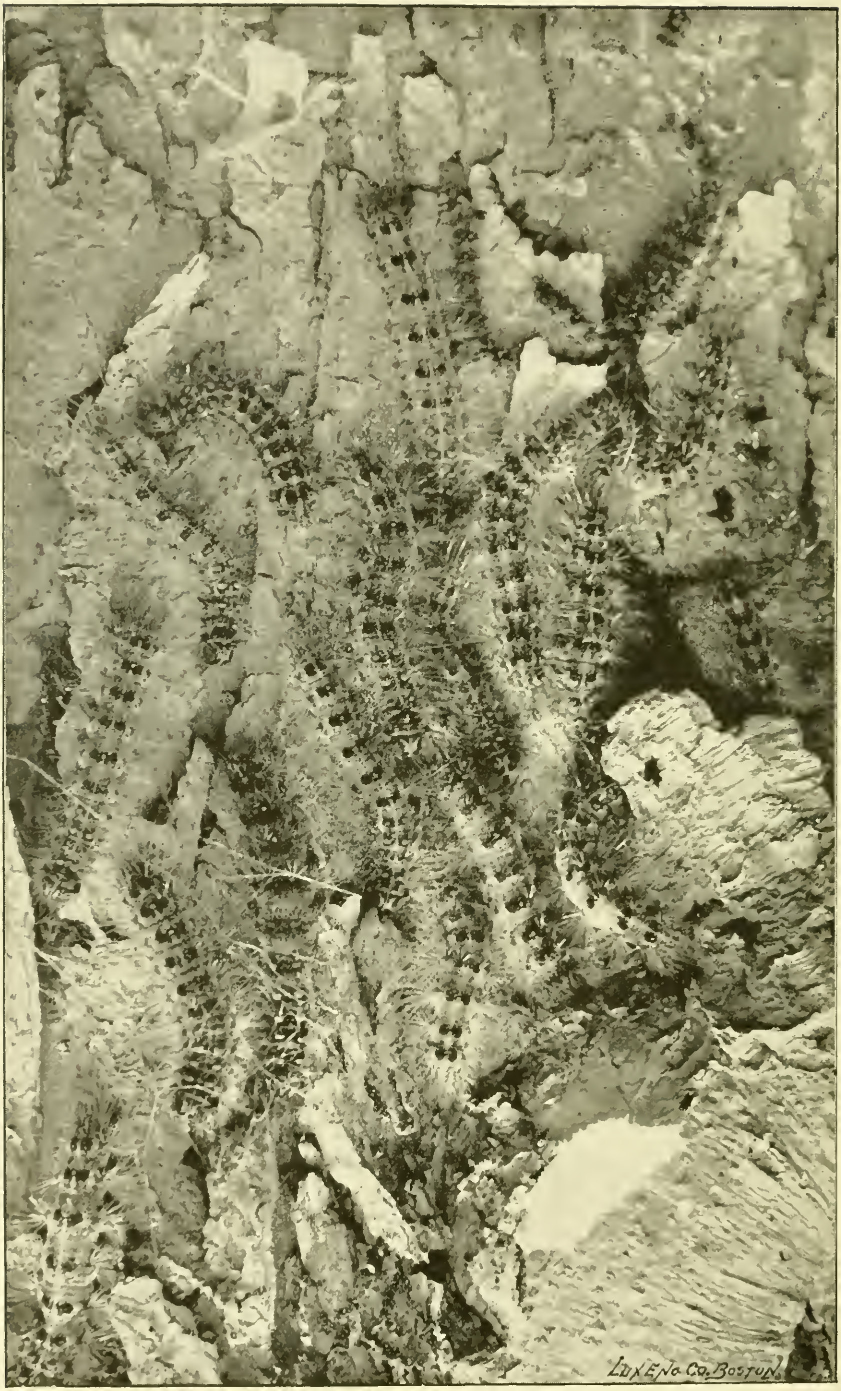
Throughout the season no measures were at any time adopted until they had been determined to be effective by experiments in the laboratory and by practice in the field. During the time employed in destroying the eggs a series of experiments was conducted to determine the best method of destroying the caterpillars. A supply was obtained by artificial hatching. The experimental work was continued during the spring and summer. The experiments with Paris green gave the best results. When it was properly applied to plants, all newly hatched caterpillars which were fed upon them in the laboratory died within a few days. In the field similar results were obtained. In the experimental work no injury to the foliage was observed, when a mixture consisting of one pound of poison to one hundred and fifty gallons of water was used. Later, glucose was added to retain the poison upon the foliage.

Spraying with Insecticides. — Paris Green.

When it became evident that Paris green was effective, preparations were made for its use on an extended scale. During the first part of May teamsters were employed, and twenty spraying outfits were put upon the road in Medford. It was soon seen that the number of men and teams was insufficient. Ten additional spraying outfits were purchased, and the effectiveness of all was doubled by improved appliances. In May and June seven superintendents were selected from the force to oversee the work of the men, and to instruct them in the use of the apparatus. One man was given general charge of the teams and implements. Each team and the accompanying squad of men was under the immediate charge of an inspector. When the apparatus had all been thoroughly tested, and the men had attained the skill requisite for its intelligent use, the entire force was sent to the periphery of the region then known to be infested, and all were instructed to work toward the centre. The infested area was thus sprayed until the middle of July. At that time numbers of caterpillars were fully grown and had stopped feeding; some had pupated and others were wandering from tree to tree. Other means were then used to destroy both caterpillars and pupæ.

Police.

When, in May, the caterpillars were seen to be spinning down from the trees, an attempt was made to maintain a cordon of police around the territory most densely infested, with a view to


LUX ENG. CO. BOSTON.

Gypsy Moth caterpillars gathered on the trunk of a tree.

ARLINGTON, MASS., JULY 9, 1891.

preventing the dissemination of the moth. The police were to stop all vehicles going out of the infested territory, and examine them; to remove caterpillars found on them; to stop all teaming of infested material, and to enforce the regulations of the department. The police outposts were examined by Professor Shaler, who soon saw that the scheme was impracticable, and would not attain the results for which it was intended. Less than two weeks' trial of the system convinced the director of its inefficiency, and it was discontinued by vote of the committee.

Burlapping.

During the spraying season experiments were made with various traps for catching the caterpillars. By observing their habits, it was seen that no trap would be effective unless it could be made to serve as a hiding place. The cavities in trees to which they resorted during the day were first burned out and then filled with cement. This cementing was done in rainy weather, when spraying was impracticable. A band of burlap was placed around the trunk of each tree. The caterpillars crowded under these bands. The men visited them daily and destroyed vast numbers, until all that remained had pupated. In two days a gang of three men killed in this manner 119,896 caterpillars and pupæ. A week after only 5,490 were found in the same locality, and a few days later but 180.

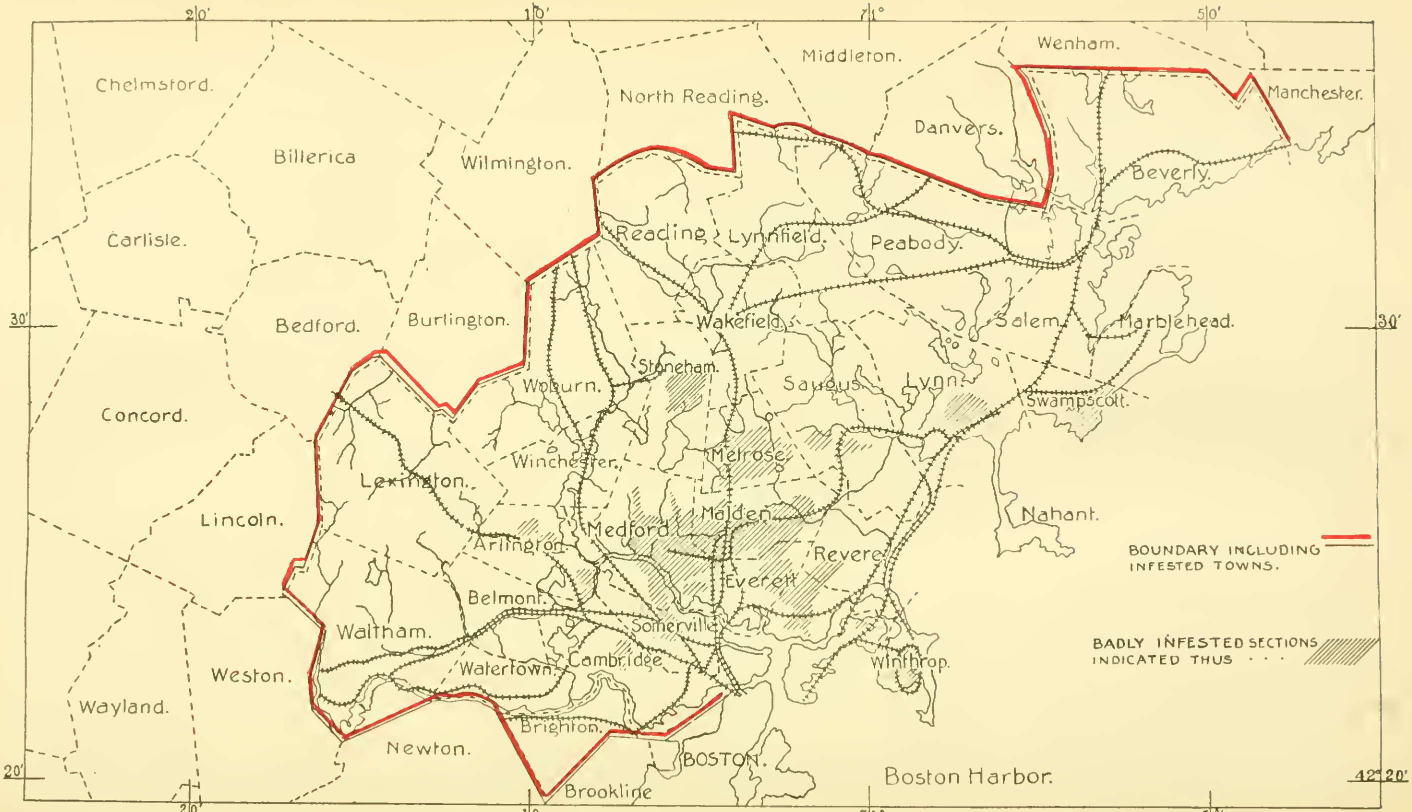
Contact Insecticides.

Early in the season experiments had been made with insecticides for killing the caterpillars and pupæ by contact. Before pupating, the caterpillars gathered in large numbers on the bark and in the cavities of trees. In these situations they were killed by spraying them with emulsions of whale-oil soap, soap powders and other insecticides. Vast numbers were destroyed in this way. In one instance two bushels of dead caterpillars and pupæ were gathered under a few apple trees. In one locality in Swampscott the stench from their decaying bodies was sickening.

In August and September the men were engaged in destroying caterpillars, pupæ, moths and eggs, wherever they were numerous. As soon as all the eggs had been deposited, the force was again reduced in numbers. The expert men who had been retained were all set to work searching for and gathering eggs in the most thickly infested portions of Malden and Medford. There again they were given the training which has been and will be of great advantage in the inspection of other towns. In the mean time they were able to destroy the greatest number of moths possible. This work was continued until the leaves fell from the trees. In December most of the men were sent into the towns and cities beyond the known infested district, there to continue the inspection, which had been interrupted in the spring by the growing leaves. Eighteen of these towns and three cities have been examined. A few scattered egg-clusters have been found in the three cities and in four of the towns. In these cases there is positive evidence that the moth has been resident two or three seasons. This is a significant fact. It leads us to infer that the work done in the centre has prevented further spreading during the present season.

Condition of the Infested Territory.

The condition of the infested territory in the spring of 1891 was found, by a hasty inspection, to be as follows: In the central part of the town of Medford, on both sides of the Mystic River, the eggs of the gypsy moth were distributed in great numbers over large areas. In the strips of intervening ground there were comparatively few. Perhaps the two most densely infested localities were the Glenwood district, into which the moth was first imported, and the most thickly settled portion on the south side of the Mystic River. The Edgeworth district in Malden was overrun, and on all the roads leading from these districts in Malden and Medford, there were colonies of the pest. In Everett, which adjoins both of these towns, they were widely scattered, and only here and there were they numerous enough to seriously threaten vegetation. The centres of population in all the towns surrounding Malden and Medford were badly infested. From these centres the moths had been distributed upon the highways, and a few were found scattered in the next series of towns to the east, north and west. Thus, while Somerville, Arlington, Winchester, Stoneham, Melrose, Saugus, Revere and Chelsea, which lie nearest to Malden, Medford and Everett, were all considerably infested, Cambridge, Belmont, Lexington, Woburn, Wakefield, Lynn and Swampscott, contained as a rule only scattered and isolated colonies. Some exceptions to this rule may be noted. There was one seriously infested locality in Arlington, near Lexington. There was one in North Cambridge, which contained as many eggs to the square foot as any in Malden or Medford. But the most peculiar instance of a large colony at a distance from the centre was in Swampscott. During the spring inspection isolated nests were found in Charlestown and Lynnfield. This inspection was continued until the foliage became so dense that the search for eggs on the trees was necessarily abandoned, and the spraying was begun.


2|0'
1|0'
71°
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20'
42°20'
Chelmsford.
Billerica
Wilmington.
North Reading.
Middleton.
Wenham.
Manchester.
Danvers.
Beverly.
Carlisle.
Reading.
Lynnfield.
Peabody.
Bedford.
Burlington.
Wakefield.
Salem.
Marblehead.
Stoneham.
Woburn.
Saugus.
Lynn.
Swampscott.
Concord.
Winchester.
Lexington.
Melrose.
Nahant.
Lincoln.
Malden.
Medford.
Arlington.
Revere.
Everett.
Belmont.
Somerville.
Waltham.
Cambridge.
Watertown.
Winthrop.
Weston.
Wayland.
Brighton.
Newton.
BOSTON.
Brookline.
Boston Harbor.
BOUNDARY INCLUDING INFESTED TOWNS.
BADLY INFESTED SECTIONS INDICATED THUS . . .

MAP OF THE REGION FOUND INFESTED IN 1891.

This area contains about 200 sq. miles.

The purpose of the December inspection was to continue the search in all directions until the limits of the infested territory should be found. In this inspection a wide belt around the infested area was explored. A few egg-clusters were found in Salem, Peabody, Marblehead, Beverly, Reading, Brighton, Watertown and Waltham. One badly infested locality was found on Breed's Island, East Boston. They were also found in Winthrop. To each of these cities and towns, which had not been previously examined, the moth had been disseminated in some way from one to three years before the work of extermination was begun by this department.

Statements and Rumors of its Existence elsewhere in New England.

Many statements have been made from time to time during the season, both by individuals and by the press, that the gypsy moth had appeared in different parts of Massachusetts and in other New England States. Rumors have been magnified and given the importance of facts. Many communications have been received both by the committee and the director from persons outside the infested territory, who feared they had discovered the gypsy moth on their own or adjoining premises. All cases of this kind which have come directly or indirectly to our notice have been fully investigated, and the depredations noticed have always been attributable to other insects. No evidence of the gypsy moth has been found.

Towns and Cities examined where no Moths were found.

During the season the routes of traffic and travel have been carefully studied, and all clues which might lead to the discovery of the moth in towns beyond the district known to be infested have been followed. The following is a list of the towns and cities which have been partially inspected in following these clues, and in which nothing has been found: —

Worcester,
Spencer,
Leicester,
Clinton,
Lancaster,
Milford,
Holden,
Lowell,
Ashburnham,
Lawrence,
Brockton,
Dorchester,
Centre Harbor, N. H.,
Athol,
Gloucester,
Manchester,
Wenham,
Danvers,
North Reading,
Wilmington,
Bedford,
Concord,
Lincoln,
Newton,
Brookline,
Wayland,
Weston.

Number of Men Employed.

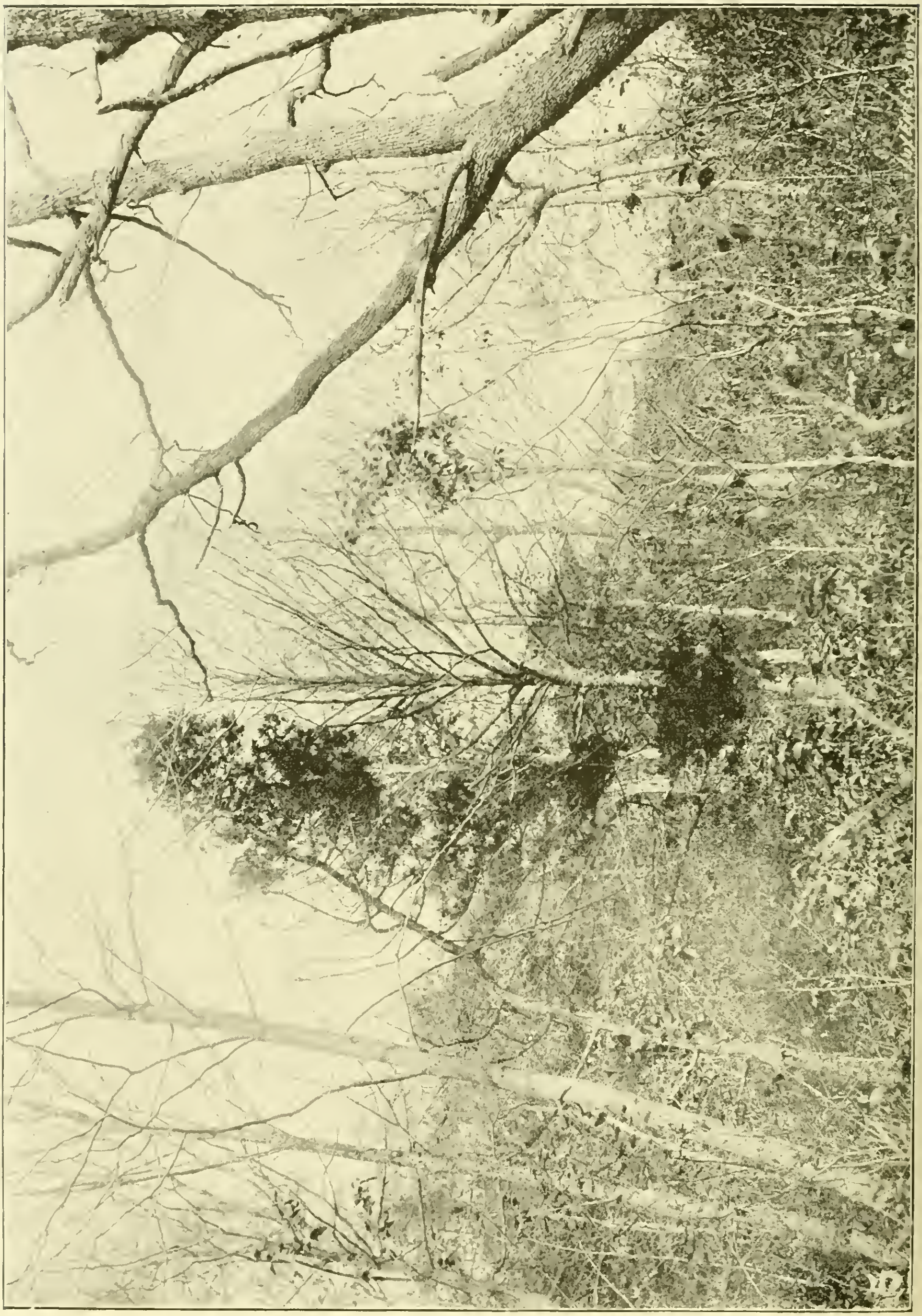
The force was increased in numbers as the men could be selected and trained. The increase continued until all spraying outfits were in the field. When the spraying season closed the force was reduced by the discharge of teamsters and laborers. The more skilled workmen were retained, and employed in destroying caterpillars and pupæ, until all the moths had laid their eggs. Then a further reduction was made, and only those most efficient in egg-gathering were retained.

Number of Men Employed Each Week.

March 20 and 21,	16
March 23–28,	40
March 30–April 4,	103
April 5–11,	129
April 13–18,	140
April 20–25,	146
April 26–May 2,	167
May 4–9,	173
May 11–16,	199
May 18–23,	195
May 25–30,	211
June 1–6,	238
June 8–13,	242
June 14–20,	211
June 22–27,	217
June 29–July 4,	209
July 6–11,	192
July 13–18,	170
July 20–25,	104
July 27–Aug. 1,	106
August 3–8,	99
August 10–15,	98
August 17–22,	96
August 24–29,	88
August 31–September 5,	83
September 7–12,	75
September 14–19,	73
September 21–26,	67
September 28–October 3,	62
October 5–10,	58
October 12–17,	58
October 19–24,	61
October 26–31,	59
November 2–7,	44
November 9–14,	44
November 16–21,	45
November 23–28,	43
November 30–December 5,	41
December 7–12,	41
December 14–19,	42
December 21–26,	42
December 28–January 2,	42

Results of the Season's Work.

The work which has been carried on during the season has been so effective that all the large colonies of the moth have been destroyed. Where in past seasons the trees bore neither leaves nor fruit, this year a good crop has been realized. In fact, many trees have broken down under their loads of fruit. Where last season thousands of eggs were seen upon the trees, now very few can be found. There is still a large area in which the eggs have not been destroyed. This should be searched with the utmost care before the leaves come again.



View of woodland infested by the Gypsy Moth.

SWAMPSCOTT, MASS., AUGUST 5, 1891.

Summary.

Following is a summary of such results of the work as can, from their nature, be accurately recorded. Much spraying, cutting and burning of brush, of which no accurate figures could be made, was done from time to time, and there was much incidental labor required in inspecting and cleaning, the results of which cannot be tabulated. The figures given are for work done from April 1, 1891, to Jan. 1, 1892.

Trees.

Number inspected,	3,591,982
Number infested,	213,828
Number cleaned of eggs,	212,432
Number sprayed,	177,415
Number cemented,	19,296
Number burlapped,	68,720
Number banded,	12,000

Buildings.

Number inspected,	87,536
Number infested,	3,647
Number cleaned of eggs,	3,574

Fences.

Number inspected,	53,219
Number infested,	6,808
Number cleaned of eggs,	6,570

A conservative estimate, based on the daily reports, has shown the number of egg-clusters destroyed during the first six weeks of the season to be 757,760; the average number of eggs in each cluster is 468; thus 353,031,680 eggs were destroyed during that time and other millions would have been gathered had they not hatched.

The number of egg-clusters gathered during October, November and December, 21,623, represents, probably, about one-third of those deposited upon the trees this fall. It will be seen by these figures that the vast increase of the moth has been checked, and only about one-tenth as many egg-clusters were found this fall as were gathered in the spring.

The Destructiveness of the Moth.

Owing to the reduction of their numbers by the measures taken during the past season, the only favorable opportunities of observing the voracity of the gypsy moth caterpillars were in two localities: one in Arlington and the other in Swampscott. They were not discovered in these places until they were far advanced in the work of defoliating the trees. In Swampscott they stripped the foliage from both evergreen and deciduous trees of all species, and even ate portions of the twigs. They did this in the face of prompt and vigorous measures which were taken to check their ravages. Fire was used as a last resort. They destroyed the foliage of shrubs, vines and all growing vegetation, even attacking the herds-grass in the fields. They spread over ten acres of woodland, and stripped a large part of it before they were checked. It is said that in Medford they destroyed all the foliage in many orchards in some previous seasons, although the owners did all in their power to stop them. From the evidence of trustworthy residents it would seem that the gypsy moth, where abundant, moves like the army worm, destroying all vegetation as it goes.

Obstacles to Extermination.

There are many circumstances connected with the life-history of this insect which must be taken into consideration in planning for its destruction. Such of these as directly and materially affect our plans are given below, with their bearing on the question of extermination: —

1. The enormous increase. The female lays a large number of eggs. These eggs are protected by a covering composed of hairs from the body of the female, and are usually deposited in sheltered situations. Under favorable conditions nearly all the eggs hatch, and, as the young caterpillars are very tenacious of life, a large proportion come to maturity.

2. Where abundant, it is found on nearly all plants of economic importance, whereas many other insects confine themselves to a few plants.

3. The long season during which it feeds. The eggs hatch from April to the last of June, and the caterpillars feed during May, June, July and August. If one crop of caterpillars be destroyed, another will follow, and the entire infested district must be gone over again and again, while the men are engaged in spraying, or destroying the caterpillars by other means.

4. The wandering habits of the caterpillars. In thickly infested regions, wherever the trees become overcrowded and much effort is required to find food, many of them become restless, and wander in all directions. At such times the slightest disturbance will cause them to spin or drop down from the branches and attach themselves to moving objects. They are thus carried to a distance.

5. The most densely infested areas correspond nearly with the

centres of population. These centres are settled largely by small householders. Flower, fruit and vegetable gardens and small orchards are abundant. The difficulty of carrying on destructive work to good advantage in such localities is evident.

Circumstances which Favor Plans for Extermination.

1. The most important and favorable circumstance of all is that the moth is apparently confined to a limited area.

2. The location of the infested territory. The eastern and a large portion of the southern part of the infested territory is bounded by the sea. This prevents all danger of the spreading of the moth in these directions. The territory most infested is frequently crossed by tidal rivers, which form a perfect barrier to migrations of the insects, except where they can cross the streams on bridges. A large part of the territory along the coast consists of salt marsh, and in this the gypsy moth has not been found, and probably could not live.

3. The moth was imported more than twenty-one years ago, and has now been found in less than thirty towns. This shows that it has not spread rapidly.

4. Travel and traffic in the infested territory moves largely to and from Boston. The business portion of Boston offers very little sustenance to leaf-eaters.

5. There are almost no exports by sea from this district, and the chances of the insect being distributed by the coast trade are therefore very few.

There are certain known habits of the gypsy moth which may be taken advantage of in making plans for its destruction: —

1. The female does not fly except diagonally downward; this greatly lessons the risk of spreading.

2. Where there are few moths, and food is abundant, they are likely to remain in the same locality.

3. The gypsy moth passes the winter in the egg, and remains in this form during the greater part of the fall, winter and early spring. At this time, when the foliage has fallen from deciduous trees, the eggs may be destroyed.

4. In the outlying districts, where the insects are few, the eggs are found almost entirely upon a few species of trees. Thus, if their numbers are greatly reduced, it is probable that they, like many other insects, will select as food certain trees and shrubs, and can be found and destroyed with comparative ease.

A careful weighing of the circumstances favorable to extermination, and those which appear unfavorable, leads to the conclusion that the greatest difficulty is experienced after the caterpillar is hatched and on the move. This obstacle must always be overcome by destroying the eggs, so that no caterpillars may emerge. Experience has shown that this is the most practical method of dealing with the moth. The chief objection urged to this method is, that some of the eggs are now laid where it is impossible to get to them. A few clusters of eggs here and there will at first escape the general destruction. When few remain, however, nature will aid materially in extermination. It has been stated that the creatures have spread over a comparatively small area in twenty-one years or more. They migrate slowly by a gradual increasing and spreading of the main body, and are thus very destructive. Recent investigations in the territory outside of the thickly infested district have furnished us with a series of data from which we glean the following : —

1. We find that many egg-clusters are infertile.
2. Some that are fertile have not hatched.
3. Others, that have evidently hatched and gone through their transformations, have apparently never reproduced.
4. In other cases the entire colony has been destroyed in some manner during its first or second season.

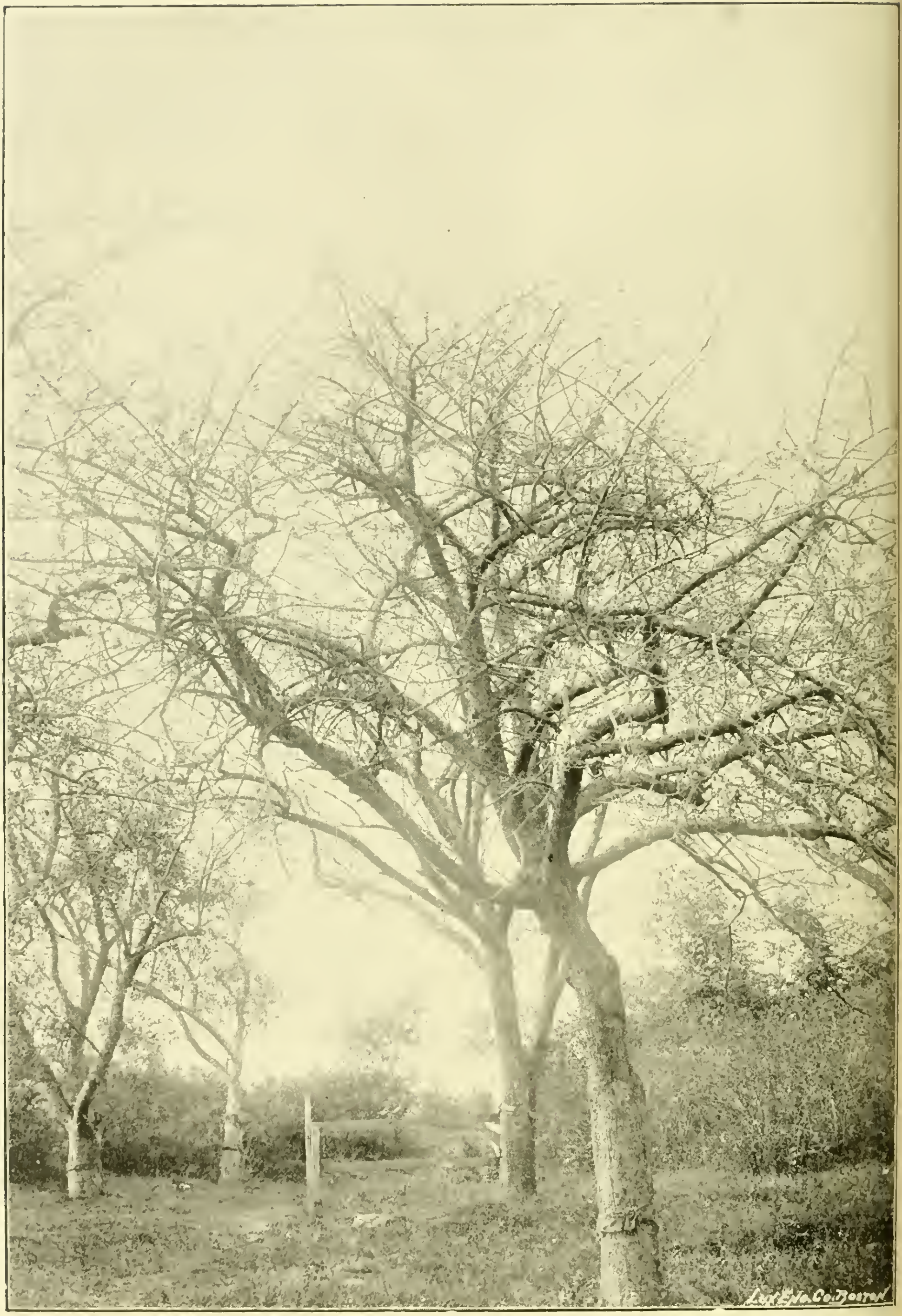
In many cases where the eggs have proved fertile the rate of increase in numbers has been very small during the second and third years. In fact, the instance where an isolated colony greatly increases in the first few years appears to be the exception.

Eggs are infertile where the female which has deposited them has been carried beyond the reach of males of the same species. Predatory larvæ attack the eggs of these and other insects, and, where only one or two eggs-clusters are found by these larvæ, they are generally utterly destroyed. Minute insects of various kinds also destroy them. As soon as the caterpillars are hatched they are exposed to the vicissitudes of our New England climate and to the attacks of birds and parasitic insects. In the smaller suburban towns, where the English sparrow is not abundant, our native birds destroy vast numbers of injurious insects. During the past season, thirteen species of birds have been observed to feed on the gypsy moth in all its stages.

Experience has demonstrated that where a species is reduced in numbers to a few individuals, and those individuals isolated, the chances are in favor of their extermination by natural causes. It is our hope and purpose to so reduce the numbers of the gypsy moth that extermination may eventually be accomplished.

Respectfully submitted,

E. H. FORBUSH,
Director of Field Work.


Lit. Eng. Co. Boston

Apple orchard stripped by caterpillars of the Gypsy Moth.

SWAMPSCOTT, MASS., AUGUST 5, 1891.

ENTOMOLOGIST'S REPORT.

To the Members of the Gypsy Moth Committee.

GENTLEMEN: — Upon receiving the appointment of entomological adviser from you last June, I visited Malden and other localities infested by the gypsy moth, and made a careful inspection of the work of destroying this insect. Repeated visits were made during the summer and fall, as often as my time would allow or the circumstances seemed to require. So far as I could judge, the work was carried on in the most practical, efficient and economical manner, and the results obtained were all that could be expected, considering the magnitude of the undertaking.

It was not expected that the insect could be exterminated in a single year; the most sanguine person who went over the infested territory and saw the obstacles to be overcome must have realized that it would be the work of time, and would be attended with great expense.

Much has been learned concerning the habits of the insect, which will prove of great value in the field work next year; and many species of native parasites have been discovered destroying the gypsy moth during the past summer, some of which have proved to be among the most useful in destroying or holding our native injurious insects in check, while others have proved to be new to science. It should be remembered that parasites, when left to themselves, do not wholly exterminate an insect pest, but that they reduce its numbers greatly, thus aiding the work of destruction. It is not wise, therefore, to leave the work of destruction to the parasites, but to so conduct the work that all the assistance they can give may be secured.

It would be a very grave mistake, in my judgment, to abandon the work of destroying the gypsy moths; but by far the wisest course to pursue will be to make so liberal an appropriation that the work may be carried on in the most vigorous manner over the entire territory, and so reduce the number of moths and extent of territory by local extermination as to cause the work to decrease in extent year by year, and therefore in expense. This is undoubtedly a case where very liberal appropriations at first will prove the most economical in the end.

That the presence of this insect in eastern Massachusetts is a great evil, and expensive to our taxpayers, no one will deny; but, if it should spread over the entire State, it will prove a far greater evil, and its extermination an utter impossibility; therefore, of these two evils it seems to me to be wise to choose the least, and employ skilled men to fight the pest where it now is, for our chances of exterminating the insect lie only in this direction. There are some who think the insect can never be exterminated; but, if this should prove true, it would even then be far cheaper to make an annual appropriation and employ experienced men to fight the pest in its present restricted territory, than to suffer it to spread over the entire Commonwealth and country, and depend upon our farmers to fight the pest, — or neglect it, as is done too frequently with other insects.

I have elsewhere published an estimate of the cost to our Massachusetts farmers of applying Paris green to the potato crop alone for the destruction of the potato beetle, and the amount was $76,000 annually. The gypsy moth, as is well known, feeds on nearly all of our trees and other plants; and, as a result, the cost of fighting this pest, if spread over the State, will be vastly greater than that of the potato beetle. Will it be wise, therefore, to allow this destructive pest to extend beyond its present limits?

I have given the most careful thought and consideration, as well as such supervision as my time would allow, to the entire work of destroying the gypsy moth during the past season, and have made frequent reports to your committee. I now feel that everything has been done that was possible, under the circumstances, and I would at this time recommend that the work be carried on next year in the same manner as it has been done this year, but on a more extensive plan, and, if possible, with more vigor.

Respectfully submitted,
(Signed) C. H. FERNALD

REPORT OF THE DAIRY BUREAU.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

The law creating this bureau went into effect Sept. 1, 1891, and requires a report to the legislature not later than January 15, consequently the bureau's first report — to Jan. 1, 1892 — covers a period of only four months. But not all of even that brief time has been available for active work. Several weeks were unavoidably consumed in the appointment, confirmation and organization of the bureau. Considerable time has also been necessarily consumed in making plans and getting ready for work, the delay being increased by the fact that the law and the office were new, and that, therefore, there were no traditions or precedents to go by. Consequently not much active field work was done before the middle of November.

As the law under which the bureau operates is, in the popular mind, intimately associated with restricting the sale of oleomargarine, there is danger that it may be considered a mere police or detective provision; and in order to show clearly the duties of the bureau we copy a portion of the law.

Chapter 412, section 7, of the Acts of 1891, says that the bureau is "subject to the general direction and control of the board of agriculture," but its particular duties are defined in section 11 of the same chapter as follows: —

"To investigate all dairy products and imitation dairy products bought or sold within the Commonwealth;

"To enforce all laws for the manufacture, transfer and sale of all dairy products and all imitation dairy products within the Commonwealth, with all powers needed for the same;

"To investigate all methods of butter and cheese making in cheese factories or creameries; and

"To disseminate such information as shall be of service in producing a more uniform dairy product of higher grade and better quality."

A careful reading of this law shows that it is very broad and comprehensive. Not only does it relate to the illegal sale of imitation butter, but it covers the whole range of dairy problems.

For instance, all questions relating to sale milk come within the province of this bureau, which can investigate the proper feeding and sanitary conditions of cows, the milk standard, and the transportation and delivery of milk. The bureau is also charged with an investigation of all methods of butter and cheese making. Further than this, the bureau is charged with the dissemination of information on these topics.

The law is not an example of class legislation, but is of vital interest to every one who buys a pint of milk or a pound of butter. At the same time, it is a protection to the farmer against an unfair competition with imitation dairy products and may be a source of much education.

The executive work of the bureau was placed by the statute in the hands of the secretary of the Board of Agriculture, but as he was already a very busy person, the legislature gave him an assistant for this work, to be appointed by the Governor. The Governor appointed to this position George M. Whitaker. The bureau has also authority to appoint such additional assistants as may be necessary, and in accordance with that provision it has secured the services of J. W. Stockwell. Professor Goessmann has been appointed chemist to the bureau.

The duties imposed by the statute seem naturally to divide themselves into two classes: those of an educational and those of a police nature. Mr. Whitaker has been assigned to the first, in addition to assisting in the general executive work; he has been instructed to inspect the creameries of the State and to respond to calls for institute work. A Babcock milk tester has been placed at his disposal. Mr. Stockwell has been appointed an agent for securing evidence of the violation of the laws in relation to the sale of oleomargarine. Polariscopes have been procured for the use of each of these gentlemen in testing oleomargarine.

The actual work accomplished so far, as stated above, includes much of a preliminary character. The first thing that was done was to codify, print and distribute the dairy laws of the State for the information of all persons interested or concerned.

Interviews have been held with the State Board of Health and also the milk inspectors of Boston and other cities, relative to working in unison with them (section 10, chapter 412) and also to avoid unnecessary duplicating of the same work.

In almost every case we have been met with the utmost courtesy and with assurances that we could work in unison with these different officers.

Interviews have also been had with the collector of internal revenue and a list of persons holding United States licenses has been secured. In some States the dairy commissioner has had trouble in obtaining this list and has sharply criticised the United States officials for such failure. This bureau has found no trouble whatever in this matter. The United States laws very emphatically forbid the commissioner of internal revenue from furnishing any lists of licensed parties. At the same time, they provide that a general alphabetical list shall be kept open for public inspection at all times, and from this public list was copied the names of those holding oleomargarine licenses.

Interviews have also been held with Dr. Goessmann relative to analyses of suspected samples of oleomargarine; and with both him and Dr. Davenport relative to microscopic tests of the same.

Most of the work done so far toward suppressing the illegal sale of oleomargarine has been that done by the bureau's agent appointed for that purpose, although in Boston Dr. Harrington, the milk inspector, has done much work in that direction. September 1 he detailed a special inspector to look up the illegal sales of oleomargarine, and has taken several cases into court for violation of the laws relating to marks, signs, wrappers, and also for violation of chapter 58 of the Acts of 1891, relative to sales of any articles which shall be in imitation of yellow butter. These were the first cases tried under the law and its constitutionality was at once questioned; two test cases were taken to the supreme court where they were argued before the full bench at the November session. The decision has not yet been rendered.

The milk inspector of Lowell has also done some good work in warning the would-be dealers of oleomargarine and restricting its illegal sale.

The assistant to the secretary has also made a number of calls of inspection in the markets in Boston and many samples have been taken. In several case she found the letter of the law violated in regard to marks upon the open tubs, although the spirit of the law was complied with; and in those cases letters of warning were sent to the parties.

Mr. Stockwell's work thus far has largely consisted in visiting parties who hold United States licenses and who are openly selling oleomargarine, in order to see that they are complying with all laws on the subject. When in a town or city he has also made other visits of inspection. He has visited Worcester, Uxbridge, Whitinsville, Northampton, Holyoke, Springfield, Athol, Amherst, Lawrence, Lowell, Fall River, Millbury, Millville and Blackstone. He has made over three hundred visits, and sent thirty-two samples to Professor Goessmann. Out of these he has twenty-seven cases ready for entry in court, some of them having several counts. Prosecution would have been begun on all before this had it not been for his sickness. As the least fine is one hundred dollars we hope and expect that the law will be self sustaining and no expense to the State.

Although active work has been in progress for so short a time, the wisdom of the law is already proven. This department of the work is in efficient hands and with the start already made we may expect good results during the year now entered upon. We believe that this work so favorably begun will prove, before the close of another year, to be a great blessing, not only to the Massachusetts dairy farmers, but to all who desire to purchase and use real butter without fear of fraud and deception and at no increase in price.

The report of the assistant to the secretary is herewith appended in his own language and made a part of our report:

"Since receiving the instructions of the dairy bureau to inspect the creameries of the State, there has been time to visit only a little over one-half of the number, owing to the way they are scattered over the whole State and to the season of the year. The work will be pushed as fast as possible.

"It is often said that when food supplies are prepared in large quantities, the work is necessarily done under conditions which are not particularly appetizing, and that peace of mind would be promoted by eating what is set before us — asking no questions. This is not true so far as creamery butter making in Massachusetts is concerned. With possibly two exceptions, all the creameries visited were found so sweet and clean as to add zest to the readiness with which their product could be eaten.

"Some statistics for the creameries visited are as follows for the months of November and December: —

1. Pounds manufactured per day — from 80 to 600.
2. Wholesale prices, delivered — from 28 to 34 cents.
3. Spaces of cream to pound of butter — from 5.70 to 6.80
4. Fat in buttermilk — from only a trace to 0.3 per cent.
5. Fat in cream — from 13.2 to 15.85 per cent.
6. Travel of cream gatherers — from 10 to 45 miles.

"The butter is sold largely in towns or cities near the place of manufacturing; some of the creameries in the western part of the State report a growing demand from New York city for unsalted butter. All of the creameries seemed to be doing well, with a brisk demand for all the butter they could make. The ratio of miles of travel to number of patrons is an important factor in the success of the creamery. One reported twenty miles travel for fourteen patrons; another twenty miles for twenty; and another twenty miles for thirty-two. The expense in each case would be the same, but in the one case it would be shared by fourteen persons and in another by thirty-two persons. To each of the latter it would be less than one-half what it would be in the former case: a suggestive point of the value of co-operation and the need of its being thorough to be most effective. The highest cost of making butter reported was eight cents per pound. The creamery reporting the most number of spaces of cream per pound of butter explained the fact by saying that none of the farmers were feeding grain and many of their cows were nibbling on frosty grass during the middle of the day; but coupled with this is the strange fact that the next largest number is reported by a creamery which has the largest number of carefully fed pure-bred Jerseys. The creameries generally allow cotton-seed meal to be fed but restrict the quantity.

"I have also begun the work of visiting institutes and explaining the work of the bureau and testing milk for butter fat. The range of samples tested was from 2.2 to 5.40. The lowest was from a cow that had recently been transported in the cars a long distance and then driven several miles in a cold storm. The latter was a grade of no predominating breed, but selected by the owner as a family cow for the quality of her milk.

"This department of the dairy bureau's work has great possibilities of benefit to the farmers and the consumers of dairy products, the full scope of which does not appear at first thought but which broadens every day one is engaged in the work. We believe it will help the farmer and improve the quality of his stock and his products, and thereby benefit every consumer."

The financial report of the Dairy Bureau is appended.

Financial Report of the Dairy Bureau.

Appropriation by Legislature of 1891, . .	$4,000 00	
C. L. Hartshorn, *Chairman*,		
Travelling and necessary expenses, .		$12 00
G. L. Clemence,		
Travelling and necessary expenses, .		23 40
D. A. Horton,		
Travelling and necessary expenses, .		30 00
G. M. Whitaker, *Assistant Executive Officer*,		
Travelling and necessary expenses, .		60 61
J. W. Stockwell, *Agent*,		
Salary, ...		275 00
Travelling and necessary expenses, .		149 54
Sundries, ...		18 69
Analyses and Tests, ...		147 00
Printing, ...		72 66
Stationery and postage, ...		5 35
Microscopes, Polariscopes, Babcock Tester, .		108 80
	$4,000 00	$903 05

C. L. HARTSHORN,
G. L. CLEMENCE.
D. A. HORTON,
Dairy Bureau.

FINANCIAL RETURNS

AND

ANALYSIS OF PREMIUMS AND GRATUITIES

OF THE

INCORPORATED SOCIETIES,

WITH

MEMBERSHIP AND INSTITUTES FOR THE YEAR

1891.

AMESBURY AND SALISBURY AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1881, Acts of 1881, chapter 204.

Originally raised by contribution $1,002.32, and now has $3,864.04 invested as a capital stock in two mortgages, bank funds, crockery, tables, etc. Total assets, $3,928.92: notes, $2,200; bank funds, $1,202.04; crockery, tables, etc., $462; bills due and unpaid, $55; cash on hand, $9.88. Total liabilities, $7.40: premiums due and unpaid, $3; outstanding bills, $4.40. Receipts in 1891, $1,235.43: bounty from State, $503; income from notes, $134; bank funds, $45.74; new members, $36; donations, $17.40; all other sources, $499.29. Expenditures in 1891, $1,118.07: premiums and gratuities paid, $550.25; current running expenses, $55.29; other expenses, $512.53. The society offered $1,200 in premiums, awarded $553.25 in premiums and gratuities, and paid $550.25, $24.50 of which went to parties not resident of the State. Two hundred and nine persons received premiums and 105 received gratuities, which went to 6 cities and towns, one of which was outside the State. Under the head of farms $10 was awarded and paid; under farm stock, $183.25 was awarded and paid; under farm and garden products $139.90 was awarded and $138.40 paid; under dairy products $1.50 was awarded and paid; under domestic manufactures $105.20 was awarded and $103.70 paid; for agricultural implements $10 was awarded and paid; for objects strictly agricultural, not specified, $14 was awarded and paid; for objects other than agricultural, not specified, $89.40 was awarded and paid. The society reports 142 members, — 134 males and 8 females. Three farmers' institutes were held at Amesbury: January 14, on "The Grass Crop" and "Breeding of Dairy Cattle;" February 24, on "General Farm Management" and "Life in the Forest of New Granada;" and March 24, on "The New South" and "Is it profitable for Essex County Farmers to breed the General Service Horse?"

ATTLEBOROUGH AGRICULTURAL ASSOCIATION.

Incorporated 1887, Acts of 1887, chapter 203.

Originally raised by contribution $20,000, and now has that amount invested as a capital stock in land, buildings, furniture, fixtures, etc. Total assets, $25,441.36 : real estate, $24,500 ; crockery, tables, etc., $500 ; cash on hand, $441.36. Total liabilities consist of a note of $7,500. Receipts in 1891, $4,238.46 ; bounty from State, $569.35 ; new members, $175 ; donations, $2 ; all other sources, $3,492.11. Expenditures in 1891, $3,797.10 : premiums and gratuities paid, $1,330.70 ; current running expenses, $350 ; interest, $191.11 ; other expenses, $1,925.29. The association offered $2,692.75 in premiums, and awarded and paid $1,330.70, which went to 21 cities and towns. Of this amount $119.65 went to 8 cities and towns outside the State. One hundred and ninety-four persons received premiums and 102 received gratuities. Of the amount awarded and paid in premiums, $254.50 was under farm stock ; $275.30 under farm and garden products ; $3 under dairy products ; $128.95 under domestic manufactures ; $68.95 for objects other than agricultural, not specified ; and six hundred dollars was paid for trotting premiums, which went mostly to Attleborough and North Attleborough. The association reports 101 members, — 95 males and 6 females. Three farmers' institutes were held : at Attleborough, February 24, on "Best Methods of Growing Potatoes," and "Top-Dressing ;" at North Attleborough, March 31, on "Indian Corn" and "Ensilage ;" at North Attleborough, November 7, on "Small Fruits and Orchards," and "Obstacles to Successful Farming in Massachusetts, and how to Overcome Them."

BARNSTABLE COUNTY AGRICULTURAL SOCIETY.

Incorporated 1844, Acts of 1844, chapter 114.

The society, in its first report to the Board in 1853, reported the amount of its permanent fund (par value) to be $1,740 ; and it now has $8,300 invested as a capital stock in real estate and bonds. Total assets $8,300.15 : real estate, $7,500 ; bonds, $800 ; cash on hand, $0.15. Total liabilities, $2,543.15 : outstanding bills, $43.15 ; mortgages or like liabilities, $2,500. Receipts in 1891, $3,733.38 : bounty from the State, $600 ; income from notes, $29.95 ; bank funds, $18 ; new members, $30 ; donations, $236.10 ; all other sources, $2,819.33. Expenditures in 1891, $3,733.23 : premiums and gratuities paid, $1,403.70 ; current running expenses, $983.69 ; interest, $180.65 ; other expenses, $1,165.19. The society offered $1,775.50 in premiums, and awarded and paid $1,403.70 in premiums and gratuities, which went to 11 cities and towns. Three hundred and thirty-five persons received premiums and gratuities. Under farm stock $458 was awarded and paid ; under field and experimental crops $88 was awarded and paid ; under farm and garden products $186.45 was awarded and paid ; under dairy products $18 was awarded and paid ; under domestic manufactures $143.25 was awarded and paid ; $485 was awarded for trotting and running, and $25 was awarded and paid for objects other than agricultural, not specified. The society reports 607 members,—371 males and 236 females. Three farmers' institutes were held : at West Barnstable, December 12, on "Growing Corn and Potatoes ;" at East Sandwich, December 19, on "Dairying in Barnstable County ;" at Barnstable, December 29, on "How to Handle the Finances of the Society."

BAY STATE AGRICULTURAL SOCIETY.

Incorporated 1886. General Laws.

The society, in its first report (1888), stated the amount raised by contribution to be at that time $2,177.16, and it now has $288.40 invested as a capital stock in cash on hand. Expenditures in 1891, $209.70 : current running expenses, $59.70 ; other expenses (Institutes), $150. The society reports a membership of 440. No regularly organized fair was held in 1891, but the extent of previous fairs held by this society can be best understood by stating that at the last fair held at Boston the expenses amounted to $31,153.99 and receipts to $30,649.81. The executive officers of the society, knowing the position that the Agricultural College holds, and the earnest work being done by its professors, decided that it would be valuable to the State if they arranged for a combination of an exhibition and institutes by a visit to the college. The report of the secretary states that on June 11, from 11.30 A.M. to 1 P.M., the exercises consisted of an address of welcome by President Goodell, a description of meteorological instruments in Professor Warner's department, and a description of museum exhibits by Professor Fernald. From 2.30 to 5.30 the barns were inspected, also crops, animals, dairy work, Hatch Experiment Station grounds, and in each case interesting and instructive lectures were given by Professor Brooks. Also, besides the various implements owned by the college and others, which were exhibited by agents and described, all animals and museums on the college grounds were freely open to the inspection of all, thereby affording a most complete " show," and carefully described whenever possible. In the evening lectures were given in the chapel hall on "The Value of Meteorology to Agriculture," by Professor Warner; "Entomology," by Professor Fernald; and "Japanese Agricultural Methods," by Professor Brooks. From 8.30 to 12.30 on the 12th a visit was made to the entomological department and insectory, with instructive addresses by Professor Fernald; a visit to the horticultural department and inspection of experiment grounds, with descriptive addresses by Professor Maynard; and a visit to the State Agricultural Experiment Station, experimental plats, barns, chemical department and department of vegetable physiology, with explanations and addresses by Dr. Goessmann and Professor Humphrey. The professors cheerfully co-operated, and were most active in making the meeting a great success. The attendance exceeded 300 persons. Besides the advantages derived by the visitors during the two days, the published accounts of the meeting have given much prominence to the good work being done at the college.

BERKSHIRE AGRICULTURAL SOCIETY.

Incorporated 1811, Acts of 1811, chapter 70.

The society in its first report to the Board in 1853, reported the amount of its permanent fund (par value) to be $3,000, and it now has $15,000 invested as a capital stock in real estate. Total assets, $15,460.53 : real estate $15,000; bills due and unpaid, estimated at $100 ; cash on hand, $360.53. Total liabilities, $8,181.25 : premiums due and unpaid, $61.25 ; outstanding bills, $120 ; mortgages or like liabilities, $8,000. Receipts in 1891, $16,266.29 : bounty from the State, $600 ; new members, $40 ; donations, $725 ; all other sources including loan of $8,800, $14,901.29. Expenditures in 1891, $16,000.82 : premiums and gratuities paid, $2,756.37 ; current running expenses, $2,616.27 ; interest, $715.87 ; other expenses, including notes paid $8,600, $9,912.31. The society offered in premiums $3,249.50, awarded $2,817.62, and paid $2,756.37. Of the amount awarded, $2,286.62 went to 25 towns within the State, and $631 to towns outside the State. Three hundred and seventy-three persons received premiums and gratuities. Under head of farms $35 was awarded and paid; under farm stock $894 was awarded and paid ; under farm and garden products $277 was awarded and paid ; under dairy products $32 was awarded and paid ; under domestic manufactures $236.75 was awarded and paid ; under agricultural implements $66 was awarded and paid ; under trotting $1,198.37 was awarded and paid (received entrance money, $310) ; under objects other than agricultural, not specified, $76.50 was awarded and paid. The society reports 1,301 members,—1,134 males and 167 females. Three farmers' institutes were held : at Hinsdale, February 25, on "Dairying ;" at Pittsfield, March 21, on "The Principles of Breeding ;" at Cheshire, November 27, on "Plant Growth, and the General Experience of Farmers with Different Crops in Soils of Different Qualities."

BLACKSTONE VALLEY AGRICULTURAL SOCIETY.

Incorporated 1884, Acts of 1884, chapter 48.

Originally raised by contribution $3,000, and now has $3,100 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $3,655.94: real estate, $3,000; crockery, tables, etc., $100; cash on hand, $555.94. Receipts in 1891, $2,390.05: bounty from the State, $600; new members, $34; donations, $23.25; all other sources, $1,732.80. Expenditures in 1891, $1,774.73: premiums and gratuities paid, $762.82; current running expenses, $1,011.91. The society offered in premiums $822.20, awarded in premiums and gratuities $786.07, and paid $762.82, which went to 17 cities and towns, 4 of which were outside the State. Fifteen dollars went to parties not resident of the State. One hundred and ninety-two persons received premiums and 25 received gratuities. Under head of farms $97 was awarded and paid; under farm stock $471 was awarded and paid; under field and experimental crops $52 was awarded and paid; under farm and garden products $79.25 was awarded and paid; under dairy products $9 was awarded and paid; under domestic manufactures $65.25 was awarded and paid; under objects other than agricultural, not specified, $64.50 was awarded and paid. The society reports 376 members, — 235 males and 141 females. Four farmers' institutes were held: at Uxbridge, February 11, on "Creameries;" at Upton, February 26, on "Stock;" at Uxbridge, March 4, on "Poultry;" at Mendon, March 25, on "Milk" and "Corn."

BRISTOL COUNTY AGRICULTURAL SOCIETY.

Incorporated 1823, Acts of 1823, chapter 32.

The society, in its first report to the Board in 1853, reported the amount of its permanent fund (par value) to be $3,240, and it now has $30,000 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $31,229.85: real estate, $29,800; crockery, tables, etc., $200; cash on hand, $1,229.85. Total liabilities, $18,144.47: premiums due and unpaid, $144.47; mortgages or like liabilities, $18,000. Receipts in 1891, $12,715.90: bounty from the State, $600; new members, $15; donations, $25; all other sources, $12,075.90. Expenditures in 1891, $11,486.05: premiums and gratuities paid, $3,763.11; current running expenses, $3,988.14; interest, $1,128.47; other expenses, $2,606.33. The society offered $5,000 in premiums; awarded in premiums and gratuities $3,907.58; and paid $3,763.11, which went to 30 cities and towns, 4 of which were outside the State, to which $76.50 was paid. Six hundred and twenty persons received premiums and 102 received gratuities. Under head of farms, $73 was awarded and paid; under farm stock $1,577 was awarded and $1,525 paid; under field and experimental crops $57 was awarded and paid; under farm and garden products $257.75 was awarded and paid; under dairy products $49 was awarded and paid; under domestic manufactures $228.81 was awarded and $212.81 paid; for trotting $1,573.02 was awarded and $1,496.55 paid; for objects other than agricultural, not specified, $92 was awarded and paid. The society reports 862 members, 680 males and 182 females. Four farmers' institutes were held: at Somerset, February 18, on "Market Gardening" and "Roads;" at Norton, March 3, on "Small Fruits for Family Use," and "Care and Management of Farm Stock;" at New Bedford, March 20, on "An Outlook on the Situation; the Farmer as a Citizen," and "Stock Raising and Dairying;" at Rehoboth, April 22, on "Small Fruits."

DEERFIELD VALLEY AGRICULTURAL SOCIETY.

Incorporated 1871, Acts of 1871, chapter 208.

Originally raised by subscription $4,094.01, and now has $9,151.21 invested as a capital stock in real estate, bank funds, crockery, tables, etc. Total assets, $9,233.36: real estate, $7,000; bank funds, $1,783.21; crockery, tables, etc., $368; bills due and unpaid, $35.57; cash on hand, $46.58. Total liabilities consist of outstanding bills to the amount of $50.40. Receipts in 1891, $2,057.26: bounty from the State, $600; new members, $161; donations, $36.42; all other sources, $1,259.84. Expenditures in 1891, $1,610.68: premiums and gratuities paid, $816.85; current running expenses, $589.49; other expenses,

$204.34. The society offered $926.80 in premiums, and awarded and paid $816.85, which went to 21 towns, 2 of which were outside the State. Six dollars and twenty-five cents went to parties not resident of the State. About 300 persons received premiums and 6 received gratuities. Under head of farm stock $559 was awarded and paid; under farm and garden products $62.85 was awarded and paid; under dairy products $16 was awarded and paid; under domestic manufactures $93.20 was awarded and paid; under trotting $50 was awarded and paid; under objects other than agricultural, not specified, $35.85 was awarded and paid. The society reports 1,463 members, — 1,159 males and 304 females. Three farmers' institutes were held: at Shelburne Falls, January 24, on "Dairying" and "Management of Farm Stock;" at Ashfield, February 7, on "Contagious Diseases of Animals;" at Charlemont, February 27, on "Turks Island Salt" and "Anatomy of Horses' Feet."

EASTERN HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1856, Acts of 1856, chapter 156.

Originally raised by contribution $3,000, and now has $7,000 invested in real estate as a capital stock. Total assets, $7,006.43: real estate $7,000; cash on hand, $6.43. Receipts in 1891, $1,916.52: bounty from State, $600, new members, $25; donations, $76.98; all other sources, $1,214.54. Expenditures in 1891, $2,009.47: premiums and gratuities paid, $1,356.10; current running expenses, $500.83; interest, $118.50; other expenses, $34.04. The society offered $1,792 in premiums, and awarded and paid $1,356.10 in premiums and gratuities, which went to 141 persons in 19 cities and towns. Under head of farm stock $364 was awarded and paid; under farm and garden products $73 was awarded and paid; under dairy products $16 was awarded and paid; under domestic manufactures $56.10 was awarded and paid; for objects other than agricultural not specified $14 was awarded and paid; $833 was awarded and paid for trotting. The society reports about 270 members. Four farmers' institutes were held at Palmer: January 13, on "Market Gardening;" February 3, on "Care, Breeding and Management of Horses;" February 17, on "Building and Repair of Highways;" and March 3, on "An Outlook on the Situation; the Farmer as a Citizen."

ESSEX AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 25.

The society in its first report to the Board in 1853, reported the amount of its permanent fund (par value) to be $9,363.66, and it now has $19,390.86 invested as a capital stock in real estate, stocks, and bonds. Total assets, $19,648.67: real estate, $5,000; stocks, $13,390.86; bonds, $1,000; bank funds, $57.81; crockery, tables, etc., $200. Receipts in 1891, $2,885.31: bounty from the State, $600; stocks, $1,030.51; bonds, $60; new members, $222; all other sources, $972.80. Expenditures in 1891, $2,650.49: premiums and gratuities paid, $1,711; current running expenses, $880.99; interest, $15; other expenses, $43.50. The society offered in premiums $3,697, awarded in premiums and gratuities $1,859.25,* and paid $1,711,† which went to 31 cities and towns. Three hundred and twenty-three persons received premiums and 244 received gratuities. Under head of farms, $129 was awarded and $115 paid; under farm stock $794 was awarded and $693 paid; under field and experimental crops $110 was awarded and $80 paid; under farm and garden products $432.50 was awarded and $466.50 paid; under dairy products $28 was awarded and $18 paid; under domestic manufactures $125.50 was awarded; under agricultural implements $76 was awarded and $58 paid; under objects other than agricultural, not specified, $210 was awarded and $158 paid. The society reports 1,512 members, — 1,501 males and 11 females. Eight farmers' institutes were held: at Peabody, January 2, on "Permanent Location of Fair," and "The New South;" at Newbury, January 16, on "Fertilizers," and "Lookout Mountain, Cave of Luray and the Natural

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* Premiums awarded are for 1891. † Premiums paid are for 1890.

Bridge;" at Georgetown, January 30, on "How can Farmers dispose of their Milk to the Best Advantage?" and "Unequal Taxation;" at Ipswich, February 13, on "Is it for the Interest of the Farmers of Essex County to develop the Farm, or the Driving Horse?" and "Agricultural Depression;" at Bradford, February 27, on subjects of special interest to women presented by lady essayists; at Wenham, March 13, on "Fertilizers," and "Food Rations for Farm Stock;" at Topsfield, March 27, on "How can Farmers Increase their Profits?" and "Poultry;" at Georgetown, December 29, on "The Horse," and "Originating, Crossing and Improvement of Vegetable Seeds."

FRANKLIN COUNTY AGRICULTURAL SOCIETY.

Incorporated 1850, Acts of 1850, chapter 104.

The society, in its first report to the Board in 1853, stated the amount of its permanent fund (par value) to be $3,768, and it now has $7,529.11 invested as a capital stock in real estate, bank stock, savings bank, cash on hand, tables, etc. Total assets, $7,540.11: real estate, $6,000; stocks, $1,020; bank funds, $404.42; crockery, tables, etc., $80; bills due and unpaid, $11; cash on hand, $24.69. Total liabilities consist of $33.20 premiums due and unpaid. Receipts in 1891, $3,008.30; bounty from the State, $600; stocks, $40; bank funds, $6.42; new members, $140; donations, $10; all other sources, $2,211.88. Expenditures in 1891, $2,479.19: premiums and gratuities paid, $1,048.98; current running expenses, $1,429.79; interest, $0.42. The society offered in premiums $1,253, awarded in premiums and gratuities $1,060.18, and paid $1,048.98, which went to 17 towns. Three hundred and thirteen persons received premiums and 13 received gratuities. Under head of farms $10 was awarded and paid; under farm stock $676.63 was awarded and $670.88 paid; under farm and garden products $184.50 was awarded and $181.50 paid; under dairy products $15 was awarded and paid; under domestic manufactures $62.50 was awarded and $58.50 paid; for all other objects strictly agricultural, not specified, $5 was awarded and paid; for trotting $500 was awarded and paid; for objects other than agricultural, not specified, $92.55 was awarded and $86.10 paid. Diplomas were awarded for agricultural implements. The society reports 1,802 members, — 1,484 males and 318 females. Three farmers' institutes were held: at Greenfield, January 17 on "Corn" and "Potatoes;" at Montague, January 31, on "Small Fruits" and "Market Gardening;" at Greenfield, February 14, on "The Construction and Ventilation of Stables," and "Tuberculosis."

HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1844, Acts of 1844, chapter 56.

The society in its first report to the Board in 1853, stated the amount of its permanent fund (par value) to be $4,860, and it now has $1,425.07 invested as a capital stock in bank funds and cash. Total assets, $1,425.07: bank funds, 1,059.49; cash on hand, $365.58. Receipts in 1891, $1,957.72: bounty from the State, $600; bank funds, $41.12: new members, $45; donations, $164.30; all other sources, $1,107.30. Expenditures in 1891, $1,731.53; premiums and gratuities paid, $683.11; current running expenses, $633.42; other expenses, $415. The society offered in premiums $1,964; awarded $845.90 in premiums and gratuities; and paid $683.11, which went to 13 towns. One hundred and sixty-six persons received premiums and 32 received gratuities. Under the head of farms $10 was awarded and paid; under farm stock $333 was awarded and $260.50 paid; under field and experimental crops $16 was awarded and paid; under farm and garden products $189 was awarded and $158.15 paid; under dairy products $6 was awarded and $3.50 paid; under domestic manufactures $77.10 was awarded and $42.27 paid; under agricultural implements $20 was awarded and $10 paid; under objects strictly agricultural, not specified, $100 was awarded and $95.25 paid; under objects other than agricultural, not specified, $94.80 was awarded and $87.44 paid. The society reports 960 members, — 778 males and

182 females. Three farmers' institutes were held: at Wilbraham, January 28, on "Poultry" and "The Dairy;" at East Longmeadow, February 25, on "Market Gardening," and "Breeding and Care of Horses;" at Westfield, March 11, on "Small Fruits," and "Taxation."

HAMPSHIRE AGRICULTURAL SOCIETY.

Incorporated 1814, Acts of 1814, chapter 19.

The society, in its first report to the Board in 1853, stated the amount of its permanent fund (par value) to be $3,255.26, and it now has $2,650 invested as capital stock in real estate, crockery, tables, etc. Total assets, $2,711.79: real estate, $2,500; crockery, tables, etc., $150; cash on hand, $61.79. Total liabilities, $802.50: outstanding bills, $52,50; mortgages or like liabilities, $750. Receipts in 1891, $1,465.40: bounty from the State, $600; income from bank funds, $75.34; new members, $52.50; donations, $147.76; all other sources, $589.80. Expenditures in 1891, $1,403.61: premiums and gratuities paid, $681.60; current running expenses, $676.66; other expenses, $45.35. The society offered in premiums $858, and awarded and paid in premiums and gratuities $681.60, which went to 14 cities and towns. Ninety-six persons received premiums and 5 received gratuities. Under head of farm stock $390 was awarded and paid; under field and experimental crops $22 was awarded and paid; under farm and garden products $125.50 was awarded and paid; under dairy products $10 was awarded and paid; under domestic manufactures $31.50 was awarded and paid; under all other objects strictly agricultural, not specified, $47 was awarded and paid; under trotting $273 was awarded and paid; under objects other than agricultural, not specified, $55.60 was awarded and paid. The society reports about 500 members, — 300 males and 200 females. Three farmers' institutes were held: at Sunderland, February 3, on "Scientific Stock Rations;" at Hadley, February 20, on "Potatoes," and "An Outlook on the Situation; the Farmer as a Citizen;" at North Amherst, March 20, on "Scientific Stock Rations."

HAMPSHIRE, FRANKLIN AND HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 125.

The society, in its first report to the Board in 1853, stated the amount of its permanent fund (par value) to be $8,141.29, and it now has $9,015 invested as a capital stock in real estate, bills due, crockery, tables, etc. Total assets, $9,015: real estate and lease, $8,800; crockery, tables, etc., $150; bills due and unpaid, $65. Total liabilities, $5,207: premiums due and unpaid, about $35; outstanding bills, $172; mortgages or like liabilities $5,000. Receipts in 1891, $3,326.07: bounty from the State, $600; new members, $65; all other sources, $2,661.07. Expenditures in 1891, $3,326.07: premiums and gratuities paid, $707.55; current running expenses, $2,418.52; interest, $200. The society offered $1,253.50 in premiums, and awarded in premiums and gratuities, $856.35, of which $707.55 was paid, and which went to 23 cities and towns. One hundred and sixty-two persons received premiums. Under head of farm stock $426.60 was awarded and $386.80 paid; under field and experimental crops $20 was awarded and paid; under farm and garden products $169.75 was awarded and $132 paid; under dairy products $24 was awarded and $21 paid; under domestic manufactures $113,75 was awarded and $96 paid; under agricultural implements $15 was awarded and $7 paid; under objects strictly agricultural, not specified, $40 was awarded and paid; under trotting $770 was awarded and $762.50 paid; under objects other than agricultural, not specified, $15 was awarded and $4.75 paid. The society reports about 1,000 members, — 700 males and 300 females. Three farmers' institutes were held: at Northampton, January 7, on "The Tariff Question;" at Northampton, January 29, on "Co-operation in Farming," and "Sheep and Lambs for Market;" at Hadley, February 20, on "Potatoes," and "An Outlook on the Situation; the Farmer as a Citizen."

HIGHLAND AGRICULTURAL SOCIETY.

Incorporated 1859, Acts of 1859, chapter 145.

Originally raised by contribution $3,262, and now has $1,100 invested as a capital stock in buildings, land, fences and track. Total assets, $1,129.97: real estate, $1,000; crockery, tables, etc., $100; cash on hand, $29.97. Receipts in 1891, $1,746.66: bounty from the State, $600; new members, $37; all other sources, $1,109.66. Expenditures in 1891, $1,716.69: premiums and gratuities paid, $602.55; current running expenses, $901.12; interest, $18.02; other expenses, $195. The society offered in premiums $756.80; and awarded and paid $602.55, which went to 18 cities and towns. One hundred and sixty-eight persons received premiums. Under head of farm stock $386.05 was awarded and paid; under field and experimental crops $34 was awarded and paid; under farm and garden products $39.70 was awarded and paid; under dairy products $7.50 was awarded and paid; under domestic manufactures $51.85 was awarded and paid; under agricultural implements $2 was awarded and paid; under trotting $32 was awarded and paid; under objects other than agricultural, not specified, $49.45 was awarded and paid. The society reports 458 members, — 327 males and 131 females. Three farmers' institutes were held: at Hinsdale, February 25, on "Dairying" and "Market Gardening;" at Becket, May 8, on "Some of the Best Ways to help the Farming Interests of Massachusetts;" and at Middlefield, September 9, on "Abandoned Farms."

HILLSIDE AGRICULTURAL SOCIETY.

Incorporated 1883, Acts of 1883, chapter 112.

Originally raised by contribution $3,113.32 and now has $4,416.18 invested as a capital stock in real estate, fixtures and cash. Total assets, $4,416.18: real estate, $4,027.53; crockery, tables, etc., $268.96; bills due and unpaid, $5; cash on hand, $114.69. Receipts in 1891, $1,438.16:

bounty from the State, $600; bank funds, $13.36; new members, $119; donations, $28.37; all other sources, $677.43. Expenditures in 1891, $1,798.06: premiums and gratuities paid, $707.50; current running expenses, $469.53; other expenses, $621.03. The society offered in premiums $660 and awarded and paid $707.50; which went to 17 cities and towns. Three hundred and fifty-five persons received premiums. Under head of farms $10.50 was awarded and paid; under farm stock, $435 was awarded and paid; under field and experimental crops $32.50 was awarded and paid; under farm and garden products $72.25 was awarded and paid; under dairy products $12.50 was awarded and paid; under domestic manufactures $79 was awarded and paid; under agricultural implements $2 was awarded and paid; under objects strictly agricultural, not specified, $26.30 was awarded and paid; under objects other than agricultural, not specified, $40.20 was awarded and paid. The society reports 540 members, — 521 males and 19 females. Five farmers' institutes were held: at Plainfield, January 6, on "New England Farm Life;" at Cummington, January 31, on general subjects; at Ashfield, February 7, on "Contagious Diseases of Animals;" at Chesterfield, February 25, on "Sheep Raising;" at Ashfield, September 29, on general subjects.

HINGHAM AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 99.

Originally raised by contribution $17,406.15 and now has $22,000 invested as a capital stock in land, buildings, furniture, etc. Total assets, $22,273.05; real estate, $20,000; crockery, tables, etc., $2,000; cash on hand, $273.05. Total liabilities $1,750 in mortgages or like liabilities. Receipts in 1891, $2,926,73: bounty from the State, $600; new members, $317; donations, $135.20; all other sources, $1,874.53. Expenditures in 1891, $2,718.60; premiums and gratuities paid, $805.10; current running expenses, $1,172.55; interest, $98.93; other expenses, $642.02. The society offered in premiums, $1,826.90; and awarded and paid in premiums and gratuities, $805.10 which went to 22 cities and towns, one of which (amount $0.25) was outside the State. One hundred and twenty-six persons received premiums and 317 received gratuities. Under head of farms $12 was awarded and paid; under farm stock $488.80 was awarded and paid; under farm and garden products $173.30 was awarded and paid; under dairy products $13 was awarded and paid; under domestic manufactures $78.50 was awarded and paid; under objects other than agricultural not specified $38 was awarded and paid. The society reports 737 members,— 517 males and 220 females. Seven farmers' institutes were held at Hingham: January 19, on "Originating and Improvement of Vegetable Seeds, and Varieties best adapted for Market Gardening;" February 23, on "Both Sides of Farming;" March 23, on "Making and Repairing of Roads;" May 18, on "History and Propagation of Plants;" June 22, on "Gleanings Suited to the Farmer, Gardener and Florist;" July 22, on "Grievances of Farmers in this Vicinity;" and August 17, on "The Gypsy Moth."

HOOSAC VALLEY AGRICULTURAL SOCIETY.

Incorporated 1860, Acts of 1860, chapter 56.

Originally raised by contribution $2,006, and now has $13,951.65 invested as a capital stock in real estate, cash on hand, crockery, tables, etc. Total assets, $13,951.65: real estate, $12,900; crockery, tables, etc. $450; cash on hand, $601.65. Receipts in 1891, $6,126.13: bounty from State, $600; new members, $170; all other sources, $5,356.13. Expenditures in 1891, $5,629.90: premiums and gratuities paid, $1,455; current running expenses, $2,476.07; interest, $62,33; other expenses, $1,636,50. The society offered in premiums, $1,991.50; and awarded and paid $1,455 which went to 19 cities and towns, 5 of which were outside the State. One hundred and seventy-six dollars and seventy-five cents went to parties not resident of the State. Three hundred and thirty-two persons received premiums. Under farms $30 was awarded and paid; under farm stock $654.75 was awarded and paid; under field and experimental crops $226 was awarded and paid; under farm and garden products $159.75 was awarded and paid; under dairy products $44 was awarded and paid; under domestic manufactures $190 was awarded and paid; under agricultural implements $18.25 was awarded and paid; under objects strictly agricultural, not specified $8.75 was awarded and paid; under trotting $1,409.50 was awarded and paid; under objects other than agricultural, not specified, $123.50 was awarded and paid. The society reports 929 members, — 914 males and 15 females. Three farmers' institutes were held: at Cheshire, November 27, on "Plant Growth, and the General Experience of Farmers with Different Crops in Soils of Different Qualities;" at Williamstown, December 4, on "Obstacles to Successful Farming and how to overcome them;" at North Adams, December 29, on "Farming as a Business."

HOUSATONIC AGRICULTURAL SOCIETY.

Incorporated 1848, Acts of 1848, chapter 101.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $6,335.33 and it now has $11,552.59 invested as a capital stock in real estate, stocks, and bank funds. Total assets, $12,440.73: real estate, $10,000; stocks, $1,000; bank funds, $552.59; crockery, tables, etc., $200; cash on hand, $688.14. Total liabilities, $571.50: premiums due and unpaid, $21.50; estimated outstanding bills, $250; note, $300. Receipts in 1891, $6,548.66: bounty from the State, $600; stocks, $49.26; bank funds, $20.22; new members, $154; all other sources, $5,725.18. Expenditures in 1891, $5,791.04: premiums paid, $2,030; current running expenses, $2,626.80; interest, $66.74; other expenses, $1,067.50. The society offered $2,427.50 in premiums; awarded $2,051.50, and paid $2,030, which went to 26 towns, 3 of which were outside the State. Two hundred and fifty-five dollars went to parties not resident of the State. Four hundred and seventeen persons received premiums. Under head of farms $18 was awarded and paid; under farm stock $1,034 was awarded, and $1,027 paid; under field and experimental crops $2.63 was awarded, and $2.57 paid; under farm and garden products $283 was awarded, and $277.50 paid; under dairy products $42 was awarded and paid; under domestic manufactures $336 was awarded, and $333 paid; under trotting $672 was awarded and paid; under objects other than agricultural, not specified, $128 was awarded and paid. The society reports 1,693 members, — 1,656 males and 37 females. Three farmers' institutes were held at Great Barrington: January 28, on "How shall the Awarding Committee be Appointed?" and "Ought the Society to discontinue Premiums on Farms and Growing Crops;" February 11, on "The True Principles of Breeding;" February 25, on "The Raising of Small Fruits and House Plants."

MARSHFIELD AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 116.

Originally raised by contribution $3,755.43 and now has $20,580.08 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $20,580.08: real estate, $19,072.78; crockery, tables, etc., $1,507.30. Total liabilities, $5,323.72: premiums due and unpaid, $119.25; outstanding bills, $204.47; mortgages or like liabilities, $5,000. Receipts in 1891, $3,251.11: bounty from the State, $600; new members, $45; donations, $10; all other sources, $2,596.11. Expenditures in 1891, $3,526.15: premiums and gratuities paid, $1,432.43; current running expenses, $1,748.72; interest, $345. The society offered in premiums, $1,749.50; awarded in premiums and gratuities, $1,551.68, and paid, $1,432.43, which went to 32 cities and towns, 1 of which (amount $0.25) was outside the State. One hundred and fifteen persons received premiums and 170 gratuities. Under head of farm stock $441.25 was awarded, and $380.75 paid; under farm and garden products $210.25 was awarded, and $163.25 paid; under dairy products $25 was awarded and paid; under domestic manufactures $201.13 was awarded, and $192.39 paid; under trotting $617 was awarded, and $615 paid. The society reports 866 members, — 563 males and 303 females. Three farmers' institutes were held at Marshfield: January 21, on "Farmers' Food," "Farmers' Institutes" and "Market Gardening;" February 18, on "Sheep Husbandry" and "Fruit and Ornamental Trees;" March 10, on "Both Sides of Farming," "Farming in Massachusetts" and "Dairying."

MARTHA'S VINEYARD AGRICULTURAL SOCIETY.

Incorporated 1859, Acts of 1859, chapter 33.

Originally raised by contribution $4,552.17 and now has $4,170.19 invested as a capital stock in real estate, notes, bank funds, crockery, tables, etc. Total assets, $4,170.19: real estate, $2,500; notes, $750; bank funds, $720.19; crockery, tables, etc., $200. Receipts in 1891, $1,218.20: bounty from the State, $600; notes, $53.46; bank funds, $28.63; new members, $18; donations, $5.75; all other sources, $512.36. Expenditures in 1891, $1,268.28: premiums and gratuities paid, $642.58; current running expenses, $324.40; other expenses, $301.30. The society offered $815 in premiums; and awarded and paid $642.58 in premiums and gratuities, which went to 4 towns. One hundred and ten persons received premiums and 125 gratuities. Under farms $6 was awarded and paid; under farm stock $340.81 was awarded and paid; under field and experimental crops $57 was awarded and paid; under farm and garden products $108.80 was awarded and paid; under dairy products $18.25 was awarded and paid; under domestic manufactures $114.67 was awarded and paid; under objects other than agricultural, not specified, $28.85 was awarded and paid. The society reports 224 members,

— 135 males and 89 females. Three farmers' institutes were held at West Tisbury: May 2, on "Taxation;" October 8, on "How to make Farming Profitable;" December 10, on "Fertilizers."

MASSACHUSETTS HORTICULTURAL SOCIETY.

Incorporated 1829, Acts of 1829, chapter 22.

The first investment was from surplus Jan. 16, 1835, and amounted to $525. The society now has $247,000 invested as a capital stock in real estate, fixtures, bonds and library. Total assets, $264,545.97: real estate, $250,000; bonds, $3,500; crockery, tables, etc., $3,500; cash on hand, $7,545.97. Total liabilities, $1,171: premiums due and unpaid, $171; mortgages or like liabilities, $1,000. Receipts in 1891, $40,510.37: bounty from the State, $600; bonds, $229.11; bank funds, $166.68; new members, $640; all other sources, $38,874.58. Expenditures in 1891, $34,095.97: premiums and gratuities paid, $5,995.37; current running expenses, $27,781.85; interest, $318.75. The society offered in premiums, $6,320; awarded in premiums and gratuities, $6,166.37; and paid $5,995.37, which went to 57 cities and towns, 7 of which were outside the State. Fifty-one dollars went to parties not resident of the State. One hundred and seventy-two* persons received premiums and *110 gratuities. Under head of farms $315 was awarded, and †$135 paid; under farm and garden products $6,372.25 was awarded, and †$5,910.37 paid. Eighty-nine dollars was awarded for window gardening. The society reports 781 members, — 735 males and 46 females. Thirteen farmers' institutes were held at Horticultural Hall, Boston: January 10, on "The Work of the Pomological Division of the United States Department of Agriculture;" January 17, on "Evergreen Trees;" January 24, on "Roses:" January 31, on "Remedies for the Grape Mildew and Other Plant Diseases;" February 7, on "Chrysanthemums;" February 14, on "The Strawberry, its Culture;

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* Except window gardeners.

† For 1890.

Theories and Methods;" February 21, on "The Geographical Distribution of Plants;" February 28, on "School Instruction in Horticulture and Its Advantages;" March 7, on "Diseases of Trees likely to follow Mechanical Injuries;" March 14, on "The Scientific Education of Gardeners;" March 21, on "Protecting our Native Birds;" March 28, on "Ferns;" and April 11, on "A Trip to the Bahama Islands."

MIDDLESEX AGRICULTURAL SOCIETY.

Incorporated as The Western Society of Middlesex Husbandmen in 1803, Special Laws, Vol. III.; name changed to The Society of Middlesex Husbandmen and Manufacturers, 1819, Acts of 1819, chapter 73; name changed to Middlesex Agricultural Society, 1852, Acts of 1852, chapter 30.

The society in its first report to the Board in 1853 reported its permanent fund (par value) to be $3,000 but it now has no capital stock. Receipts in 1891, $3,678.13: donations, $849.63; all other sources, $2,828.50. Expenditures in 1891, $3,678.13: premiums and gratuities paid, $568.50; current running expenses, $2,466.80; other expenses, $642.83. The society offered in premiums $1,596 and awarded and paid $568.50 in premiums and gratuities, which went to 21 cities and towns, 1 of which was outside the State. One dollar went to parties not resident of the State. Forty-six persons received premiums and 10 gratuities. Under head of farms $7 was awarded and paid; under farm stock, $282 was awarded and paid; under field and experimental crops, $58 was awarded and paid; under farm and garden products $176.50 was awarded and paid; under domestic manufactures $20 was awarded and paid; under agricultural implements $25 was awarded and paid; under trotting $1,800 (received entry fees, $1,155) was awarded and paid. The society reports 1,030 members, — 678 males and 352 females. Three farmers' institutes were held: at Bedford, February 27, on "The Silo and Feed for Cattle" and "The

New England Farmer;" at Hudson, March 27, on "Fruit Culture" and "Vegetable Culture;" at Arlington, December 8, on "Swine" and "Market Gardening."

MIDDLESEX NORTH AGRICULTURAL SOCIETY.

Incorporated 1855, Acts of 1855, chapter 315.

Originally raised by contribution $3,000 and now has $28,000 invested as a capital stock in real estate. Total assets, $29,461.44: real estate, $28,000; crockery, tables, etc., $400; bills due and unpaid, $505.44; cash on hand, $556. Total liabilities, $3,610.75: premiums due and unpaid, $110.75; mortgages or like liabilities, $3,500. Receipts in 1891, $3,709.71: bounty from the State, $600; new members, $132; all other sources, $2,977.71. Expenditures in 1891, $3,576.90: premiums and gratuities paid, $973.25; current running expenses, $1,876; interest, $187.50; other expenses, $540.15. The society offered in premiums $1,276.50; awarded in premiums and gratuities $882.25; and paid $973.25, which went to 15 towns. One hundred and seventy-five persons received premiums and 58 gratuities. Under head of farm stock $440.75 was awarded, and $391.25 paid; under farm and garden products $339.75 was awarded, and $303.50 paid; under dairy products $3 was awarded; under domestic manufactures $129.25 was awarded, and $121.75 paid. Diplomas were awarded for agricultural implements. The society reports 650 members, — 440 males and 210 females. Five farmers' institutes were held: at Lowell, January 14, on "Productive Labor as Relative to Capital in Maintenance of the Social Structure" and "Small Fruits for Family Use;" at Acton, February 18, on "Commercial Fertilizers and how to Use them" and "Economical Feeding of Stock;" at Lowell, March 18, on "Artificial Drainage of the Soil" and "Plant Growth;" at Westford, April 15, on "Benefits of Agricultural Societies to the Farmers" and "Fruit;" at North Billerica, October 29, on "Best Methods of Raising and Curing Ensilage" and "Chemical Fertilizers."

MIDDLESEX SOUTH AGRICULTURAL SOCIETY.

Incorporated 1854, Acts of 1854, chapter 84.

Originally raised by contribution $3,000 and now has $15,000 invested as a capital stock in real estate. Total assets, $15,259.61: real estate, $15,000; crockery, tables, etc., $50; bills due and unpaid, $200; cash on hand, $9.61. Total liabilities, $7,423.57: premiums due and unpaid, $35; outstanding bills, $88.57; mortgages or like liabilities, $7,300. Receipts in 1891, $1,950.71: bounty from the State, $600; new members, $38; donations, $34.40; all other sources, $1,278.31. Expenditures in 1891, $1,906.10: premiums and gratuities paid, $970.55; current running expenses, $565.02; interest, $370.53. The society offered $1,443.70 in premiums: awarded $1,005.55 and paid $970.55 which went to 7 towns. One hundred and nineteen persons received premiums. Under head of farms $17 was awarded and paid; under farm stock $173.25 was awarded and paid; under field and experimental crops $55 was awarded, and $20 paid; under farm and garden products $110.75 was awarded and paid; under domestic manufactures $46.50 was awarded and paid; under objects strictly agricultural not specified, $45.50 was awarded and paid; under trotting $575 was awarded and paid; under objects other than agricultural not specified $9.50 was awarded and paid. The society reports 572 members, — 379 males and 193 females. Three farmers' institutes were held at Framingham: February 5, on "The New South;" February 11, on "The New South, Lookout Mountain, Natural Bridge, etc.;" March 26, on "Market Gardening."

NANTUCKET AGRICULTURAL SOCIETY.

Incorporated 1856, Acts of 1856, chapter 25.

Originally raised by contribution $3,500 and now has $3,200 invested as a capital stock in real estate. Total assets, $3,273.75: real estate, $3,200; cash on hand, $73.75. Receipts in 1891, $1,345.41: bounty from the State, $600; new members, $20; donations, $46.62; all other sources,

$678.79. Expenditures in 1891, $1,281.66: premiums and gratuities paid, $683.25; current running expenses, $598.41. The society offered in premiums, $1,377.75; awarded in premiums and gratuities, $697; and paid, $683.25. Two hundred and nineteen persons received premiums and 123 gratuities. Under head of farms $29 was awarded and paid; under field and experimental crops $6 was awarded and paid; under farm stock $392.50 was awarded, and $389 paid; under farm and garden products $93 was awarded, and $92 paid; under dairy products $7.50 was awarded and paid; under domestic manufactures $58.25 was awarded, and $53 paid; under trotting $30 was awarded and paid; under objects other than agricultural, not specified, $80 was awarded and $76.75 paid. The society reports 468 members, — 204 males and 264 females. Three farmers' institutes were held at Nantucket: November 14, on "Insects Injurious to Vegetation;" November 30, on "Profits in Root Culture;" December 10, on "Milch Cows and Dairy Farming."

OXFORD AGRICULTURAL SOCIETY.

Incorporated 1888, Acts of 1888, chapter 93.

Originally raised by contribution $4,400 and now has $8,019.08 invested as a capital stock in real estate, cash on hand, crockery, tables, etc. Total assets, $8,019.08; real estate, $6,700; crockery, tables, etc., $200; cash on hand $1,119.08. Liabilities consist of a mortgage of $2,000. Receipts in 1891, $2,886.40: bounty from the State, $600; new members, $108; donations, $48; all other sources, $2,130.40. Expenditures in 1891, $1,767.32: premiums and gratuities paid, $1,068.65; current running expenses, $325; interest, $100; other expenses, $273.67. The society offered in premiums, $1,500; awarded $1,094.50; and paid $1,068.65 which went to 18 cities and towns, 4 of which were outside the State. One hundred and fifty-eight dollars went to parties not resident of the State. One hundred and forty-eight persons received premiums. Under head of farms $45 was awarded, and $43.50 paid; under farm stock $491 was awarded, and $472.40 paid; under field and experimental crops $45 was awarded, and $44.06 paid; under farm and garden products $22.25 was awarded, and $21.88 paid; under dairy products $11 was awarded and paid; under domestic manufactures $27 was awarded, and $23.94 paid; under agricultural implements $3 was awarded and paid; under trotting $425 was awarded and paid; under objects other than agricultural, not specified, $25.25 was awarded, and $23.87 paid. The society reports 620 members, — 333 males and 287 females. Three farmers' institutes were held: at Sutton, February 26, on "An Outlook on the Situation, the Farmer as a Citizen" and "The Sheep Industry;" at Oxford, March 26, on "Road Making," "Formation of Soils," "Best Breeds of Dairy Cows" and "Observations of Western Farming;" at Oxford, December 10, on "Horses and Sheep" and "Care of Dairy Stock."

PLYMOUTH COUNTY AGRICULTURAL SOCIETY.

Incorporated 1819, Acts of 1819, chapter 2.

The society in its first report to the Board in 1853 reported its permanent fund (par value) to be $9,550 and it now has $30,317.96 invested as a capital stock in real estate, cash on hand, crockery, tables, etc. Total assets, $30,317.96: real estate, $30,000; crockery, tables, etc., $200; cash on hand, $117.96. The liabilities of the society consist of notes to the amount of $1,700. Receipts in 1891, $16,642.33: bounty from the State, $600; new members, $45; donations, $4; all other sources, $15,993.33. Expenditures in 1891, $16,524.37: premiums and gratuities paid, $3,283.60; current running expenses, $2,719.16; interest, $454.34; other expenses, $10,067.27. The society offered $3,847.50 in premiums, and awarded and paid in premiums and gratuities, $3,283.60, which went to 27 cities and towns, 2 of which were outside the State. Three hundred and sixty-two dollars and fifty cents went to parties not resident of the State. Two hundred and ninety-seven persons received premiums and 3 gratuities. Under farms $181 was awarded and paid; under farm stock $849 was awarded and paid; under field and experimental crops $46 was awarded and paid; under farm and garden products $178.70 was awarded and paid; under dairy products $31 was awarded and paid; under domestic manufactures $137.15 was awarded and paid; under trotting $1,795 was awarded and paid; under objects other than agricultural, not specified, $65.75 was awarded and paid. The society reports 1,670 members, — 1,067 males and 603 females. Three farmers' institutes were held: at Hanson, January 27, on "An Outlook on the Situation, the Farmer as a Citizen;" at West Bridgewater, March 26, on "Care and Management of Milch Cows;" at Bridgewater, December 15, on "Points on Market Gardening."

SPENCER FARMERS AND MECHANICS ASSOCIATION

Incorporated 1888, Acts of 1888, chapter 87.

Originally raised by contribution $4,034.08 and now has $7,800 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $7,915.13: real estate, $7,000; crockery, tables, etc., $800; cash on hand, $115.13. Liabilities consist of a mortgage of $1,800. Receipts in 1891, $3,575.96: bounty from the State, $600; new members, $191; all other sources, $2,784.96. Expenditures in 1891, $3,500.53: premiums and gratuities paid, $1,663.94; current running expenses, $921.59; interest, $115; other expenses, $800. The society offered in premiums $2,180; awarded in premiums and gratuities, $1,679.25; and paid $1,663.94, which went to 25 cities and towns, 2 of which were outside the State. One hundred and forty dollars went to parties not resident of the State. One hundred and eighty-three persons received premiums and 38 gratuities. Under head of farms $54 was awarded and paid; under farm stock $753.50 was awarded, and $741.60 paid; under field and experimental crops $29.75 was awarded, and $28 paid; under farm and garden products $98.75 was awarded, and $97 paid; under dairy products $10 was awarded and paid; under domestic manufactures $45.25 was awarded and paid; under agricultural implements $10 was awarded and paid; under trotting $678 was awarded, and $672 paid; under objects other than agricultural, not specified, $6 was awarded and paid. The society reports 951 members, — 529 males and 422 females. Three farmers' institutes were held: at Oakham, January 20, on "Abandoned Farms" and "Silos and the Treatment of Ensilage;" at Spencer, February 10, on "Small Fruits for Family Use" and "How does Taxation affect the Farmer?"; at Spencer, February 27, on "Essentials to Success in Farming" and "License as it affects the Farmer."

UNION AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 110.

Originally raised by contribution $4,447.23 and now has $9,579.77 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $9,579.77: real estate, $7,946.88; crockery, tables, etc., $1,632.89. Total liabilities, $91.73: premiums due and unpaid, $84.47; outstanding bills, $7.26. Receipts in 1891, $2,626.01: bounty from the State, $600; notes, $4.50; new members, $109; all other sources, $1,912.51. Expenditures in 1891, $2,693.27: premiums and gratuities paid, $1,162.63; current running expenses, $839.69; interest, $34; other expenses, $656.95. The society offered $1,756 in premiums; awarded $1,247.10 in premiums and gratuities; and paid $1,162.63, which went to 26 cities and towns, 2 of which were outside the State. One dollar and seventy-five cents went to parties not resident of the State. Two hundred and nineteen persons received premiums and 96 gratuities. Under farms $7.50 was awarded, and $5 paid; under farm stock, $624.75 was awarded, and $569.50 paid; under field and experimental crops $40 was awarded, and $37.50 paid; under farm and garden products $38.75 was awarded, and $36.87 paid; under dairy products $12 was awarded and paid; under domestic manufactures $84.60 was awarded, and $73.64 paid; under agricultural implements $1.50 was awarded, and $1.25 paid; under trotting $380 was awarded and paid; under objects other than agricultural, not specified, $58 was awarded, and $47.24 paid. The society reports 1,125 members, — 518 males and 607 females. Six farmers' institutes were held at Blandford: January 26, on "General Farming;" February 25, on "Abandoned Farms;" March 11, on "Corn Crop for Hill Farms;" March 25, "Care and Raising of Neat Stock;" April 8, on "Our Pastures;" June 3, on "Care and Management of Milch Cows," and "General Farming; Outlook for the Future."

WEYMOUTH AGRICULTURAL AND INDUSTRIAL SOCIETY.

Incorporated 1891, Acts of 1891, chapter 77.

The society in its first report to the Board in 1890 stated that the sum originally raised by contribution had increased to $10,270 and it now has that amount invested as a capital stock in real estate, crockery, tables, etc. Total assets, $10,520.01: real estate, $10,000; crockery, tables, etc., $270; cash on hand $250.01. Liabilities consist of a mortgage of $2,500. Receipts for 1891, $3,892.68: bounty from the State, $926.85;* all other sources, $2,965.83. Expenditures in 1891, $3,637.72: premiums and gratuities paid, $671.02; current running expenses, $2,282.35; interest, $184.35; paid on mortgage, $500. The society offered $990.85 in premiums; awarded $691.14 in premiums and gratuities, and paid $671.02 which went to 23 cities and towns, 1 of which was outside the State. Fifty dollars went to parties not resident of the State. One hundred and twenty-eight persons received premiums and 144 gratuities. Under head of farms $10 was awarded and paid; under farm stock $415.65 was awarded, and $404.75 paid; under field and experimental crops $4 was awarded and paid; under farm and garden products $134.22 was awarded, and $132.25 paid; under dairy products $4.50 was awarded and paid;

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* $463.55 for 1889 and $463.30 for 1890.

under domestic manufactures $105.42 was awarded, and $100.17 paid; under objects other than agricultural, not specified, $27.35 was awarded, and $25.35 paid. The society reports 459 members, — 451 males and 8 females. Three farmers' institutes were held at South Weymouth: April 9, on "Seeds and Vegetables;" October 5, on "Horses;" and November 28, on "Cattle."

WORCESTER AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 168.

The society in its first report to the Board in 1853 reported its permanent fund (par value) to be $7,730 and it now has $130,000 invested as a capital stock in real estate. Total assets, $134,244.26: real estate, $130,000; bank funds, $4,044.26· crockery, tables, etc., $200. Liabilities $44,000 in mortgages or like liabilities. Receipts in 1891, $26,149.60: bounty from the State, $600; bank funds, $121.18; new members, $540; all other sources, $24,888.42. Expenditures in 1891, $24,942.35: premiums and gratuities paid, $8,979; current running expenses, $11,044.25; interest, $2,009.70; other expenses, $2,909.40. The society offered $10,486.50 in premiums, and awarded and paid $8,979 in premiums and gratuities, which went to 68 cities and towns, 24 of which were outside the State. Two thousand two hundred and fifty-nine dollars went to parties not resident of the State. Three hundred and ninety-one persons received premiums and 4, gratuities. Under the head of farms $154 was awarded and paid; under farm stock, $3,553 was awarded and paid; under farm and garden products $1,000 was awarded and paid; under dairy products $116 was awarded and paid; under domestic manufactures $162.75 was awarded and paid; under trotting $3,325 was awarded and paid; under objects other than agricultural, not specified, $698.25 was awarded and paid. The society awarded diplomas for canned and preserved fruits and vegetables, and diplomas and medals for agricultural implements. The society reports 1,884 members; 1,820 males and 64 females. Three farmers' institutes were held: at Westboro, January 21, on "Poultry; Incubation and Management" and "Sheep Husbandry;" at Sutton, February 26, on "An Outlook on the Situation, the Farmer as a Citizen" and "Sheep Husbandry;" at Shrewsbury, March, 25, on "Care and Management of Milch Cows" and "Insects and Fungi Attacking our Trees."

WORCESTER EAST AGRICULTURAL SOCIETY.

Incorporated 1890, Acts of 1890, chapter 41.

Originally raised by contribution $1,015 and now has $2,296.23 invested as a capital stock in real estate, cash, crockery, tables, etc. Total assets, $2,332.23: real estate, $1,516.99; bank funds, $500; crockery, tables, etc., $160.90; cash on hand, $154.34. Receipts in 1891, $4,541.50: bounty from the State, $203; bank funds, $540.08; new members, $194; donations, $336; all other sources, $3,268.42. Expenditures in 1891, $3,982.45: premiums and gratuities paid, $1,174.60; current running expenses, $2,415.59; other expenses, $392.26. The society offered in premiums, $1,575.25; awarded in premiums, $1,373.35; and paid, $1,174.60, which went to 18 cities and towns. One hundred and ninety-eight persons received premiums. Under head of farms $32 was awarded and paid; under farm stock $576.50 was awarded, and $561.50 paid; under farm and garden products $354.75 was awarded, and $326.50 paid; under dairy products $44 was awarded and paid; under domestic manufactures $74.65 was awarded, and $71.12 paid; under agricultural implements $17 was awarded and paid; under objects other than agricultural, not specified, $155.60 was awarded and paid. The society reports 572 members, — 401 males and 171 females. Three farmers' institutes were held: at Lancaster, January 9, on "What constitutes Success in Agriculture?;" at Harvard, February 27, on "The Best Management of the Dairy and Best Way of Disposing of the Products;" at Bolton, March, 25, on "Orchard Culture" and "Raising of Small Fruits."

WORCESTER NORTH AGRICULTURAL SOCIETY.

Incorporated as the Fitchburg Agricultural Society 1852, Acts of 1852, chapter 79; name changed to Worcester North Agricultural Society 1853, Acts of 1853, chapter 359.

Originally raised by contribution $2,128, and now has $5,204.62 invested as a capital stock in real estate, fixtures, and cash. Total assets, $5,204.62: real estate, $3,000; crockery, tables, etc., $350; cash on hand, $1,854.62; Receipts in 1891, $4,699.09: bounty from State, $600; new members, $59; all other sources, $4,040.09. Expenditures in 1891, $4,394.03; premiums and gratuities paid, $2,155.71; current running expenses, $2,238.32. The society offered no fixed sum in premiums; awarded $2,257.91; and paid $2,155.71, which went to 17 cities and towns, 2 of which were outside the State. One hundred and fifty-five dollars went to parties not resident of the State. Under farms $31 was awarded and paid; under farm stock $468.50 was awarded, and $428.75 paid; under farm and garden products $252.40 was awarded, and $243.90 paid; under dairy products $3 was awarded and paid; under domestic manufactures $66.60 was awarded, and $56.90 paid; under agricultural implements $29 was awarded, and $19 paid; under objects strictly agricultural, not specified, $35 was awarded, and $25 paid; under field sports $884.99 was awarded and paid; under trotting $1,350 was awarded, and $610 paid; under objects other than agricultural, not specified, $167.50 was awarded and $93.50 paid. The society reports 769 members, — 716 males and 53 females. Three farmers' institutes were held: at Westminster, January 7, on "Cultivation of Grass;" at Ashby, February 17, on "Poultry Culture;" at Leominster, March 13, on "Milk" and "Essentials to Success in Farming."

WORCESTER NORTHWEST AGRICULTURAL AND MECHANICAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 117.

Originally raised by contribution $3,400 and now has $10,287.22 invested as a capital stock in real estate, crockery, tables, cash on hand, etc. Total assets, $10,487.22: real estate, $10,000; crockery, tables, etc., $400; cash on hand, $87.22. A mortgage of $200 is reported. Receipts in 1891, $4,897.44: bounty from State, $600; new members, $100; all other sources, $4,197.44. Expenditures in 1891, $4,330.99; premiums and gratuities paid, $1,885.24; current running expenses, $2,391.75; interest, $54. The society offered $2,646.45 in premiums; awarded in premiums and gratuities, $1,953.50; and paid $1,885.24, which went to 176 persons in 35 cities and towns. Thirty-seven dollars and thirty-three cents went to 3 cities and towns outside the State. Under head of farms $28 was awarded, and $27 paid; under farm stock $627.75 was awarded and $599.33 paid; under farm and garden products $155.50 was awarded, and $145.50 paid; under dairy products $19 was awarded, and $18.33 paid; under domestic manufactures $49.25 was awarded, and $46.25 paid; $0.50 was awarded and paid for agricultural implements; $1,007.50 was awarded and paid for trotting; and for objects other than agricultural, not specified, $66 was awarded, and $40.83 paid. The society reports 882 members, — 591 males and 291 females. Four farmers' institutes were held: at Royalston, January 28, on "Grass Crop" and "The Breeding of Dairy Cattle;" at Petersham, February 20, on "Business and Personal Expenses" and "Farm Æsthetics:" at Phillipston, March 18, on "How to Improve our Farms" and "Dairy Stock and its Care:" at Gardner, March 21, on "Indian Corn" and "Poultry."

WORCESTER SOUTH AGRICULTURAL SOCIETY.

Incorporated 1855, Acts of 1855, chapter 278.

Originally raised by contribution $3,127.40 and now has $8,500 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $8,688.03: real estate, $8,000; crockery, tables, etc., $500; cash on hand, $188.03. Total liabilities, $1,578.75: premiums due and unpaid, $78.75; mortgages or like liabilities $1,500. Receipts in 1891, $4,641.51: bounty from the State $600; new members, $79; all other sources, $3,962.51. Expenditures in 1891,

$3,096,40: premiums and gratuities paid, $1,600.10; current running expenses, $1,343,90; interest, $152.40. The society offered in premiums $2,124.25; awarded in premiums and gratuities $1,678.85; and paid $1,600.10, which went to 24 cities and towns. One hundred and five persons received premiums and 79 gratuities. Under head of farms $54 was awarded and paid; under farm stock $808.50 was awarded, and $778.50 paid; under field and experimental crops $28.75 was awarded, and $18.25 paid; under farm and garden products $103.85 was awarded, and $80.60 paid; under dairy products $24 was awarded and paid; under domestic manufactures $87.25 was awarded, and $74.25 paid; under agricultural implements $12 was awarded and paid; under objects strictly agricultural, not specified, $50 was awarded and paid; under trotting $510 was awarded and paid; under objects other than agricultural, not specified, $38 was awarded and paid. The society has 1,835 members, — 926 males and 909 females. Three farmers' institutes were held: at Brookfield, January 20, on "Sanitary Arrangements of Farm Houses and Barns" and "The Yeast of the Soil;" at Charlton, February 25, on "Depression in Agriculture" and "Observations of Agriculture in the South;" at Sturbridge, December 29, on "The Dairy Bureau and Testing of Milk" and "Sanitary Arrangements of Farm Houses and Barns."

WORCESTER COUNTY WEST AGRICULTURAL SOCIETY.

Incorporated 1851, Acts of 1851, chapter 278.

The society in its first report to the Board in 1853 reported its permanent fund (par value) to be $3,175 and it now has $12,600 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $13,134.75: real estate, $11,600; crockery, tables, etc., $1,000; cash on hand, $534.75. Receipts in 1891, $2,093.71: bounty from the State, $600; new members, $80; donations, $55.63; all other sources, $1,358.08. Expenditures in 1891, $1,970.09: premiums and gratuities paid, $1,186; current running expenses, $784.09. The society offered in premiums, $1,555.50; awarded in premiums and gratuities, $1,241.63; and paid, $1,186, which went to 23 cities and towns. One hundred and thirty-four persons received premiums and 37 gratuities. Under head of farms $35 was awarded, and $33.50 paid; under farm stock, $527.50 was awarded, and $493 paid; under field and experimental crops $23.75 was awarded, and $23.25 paid; under farm and garden products $94.80 was awarded, and $89.08 paid; under dairy products $12 was awarded, and $10.50 paid; under domestic manufactures $42.55 was awarded, and $41.55 paid; under agricultural implements $4 was awarded; under trotting $528 was awarded and paid; under objects other than agricultural, not specified, $26 was awarded, and $22.75 paid. The society reports 557 members, — 511 males and 46 females. Three farmers' institutes were held at Barre: February 20, on "Small Fruits for Family Use;" March 6, on "Profitable Dairying" and "How Shall We Feed our Plants?;" March 20, on "How to Render our Institutes More Successful" and "Massachusetts Agriculture, Yesterday, To-day and To-morrow."

SUMMARY.

Number of societies,	37
Amount held invested or well secured as a capital stock,	$742,558 26
Assets of the societies,	776,831 26
Liabilities of the societies,	116,190 39
Receipts in 1891,	208,292 30
Expenditures in 1891,	191,157 74
Bounty received from the State,	20,802 20
Current running expenses,	86,501 66
Amount of premiums offered,	79,645 61
Amount of premiums and gratuities awarded,	60,869 56
Amount of premiums and gratuities paid,	59,168 71
Amount awarded under head of farms,	1,440 00
Amount awarded under head of farm stock,	22,145 79
Amount awarded under head of field and experimental crops,	1,029 63
Amount awarded under head of farm and garden products,	13,025 02
Amount awarded under head of dairy products,	686 75
Amount awarded under head of domestic manufactures,	3,655 49
Amount awarded under head of miscellaneous,	4,308 64
Amount awarded under head of trotting,	21,416 39
Number of persons who received premiums,	7,480
Number of persons who received gratuities,	2,225
Total male membership of the societies,	24,143
Total female membership of the societies,	7,465
Total membership of the societies,	31,608
Number of farmers' institutes held in 1891.	141

ANNUAL MEETING

OF THE

BOARD OF AGRICULTURE

AT BOSTON.

FEBRUARY 2, 3 AND 4, 1892.

ANNUAL MEETING.

The Board met at the office of the secretary, in Boston, on Tuesday, Feb. 2, 1892, at 12 o'clock, it being the Tuesday preceding the first Wednesday in February. In absence of the Governor, Hon. J. S. **Grinnell** was elected president *pro tem.*

Present: His Excellency Governor Russell, Messrs. Appleton, Alger, J. D. Avery, J. G. Avery, Bancroft, Bird, Bowker, Bursley, Clapp, Clemence, Cook, Cruickshanks, Cushman, Edson, Fowler, Goodell, Grinnell, Harwood, Hartshorn, Hayden, Hersey, Horton, Howe, Kilbourn, Kimball, Mills, Newhall, Pratt, Rawson, Reed, Richards, J. H. Rowley, Sargent, Shaler, Shaw, Stockwell, Taylor, Varnum, Ware, Warren, West, Wood.

A committee of three, to examine and report upon the credentials of newly elected members, was appointed by the Chair: Messrs. Cushman, Edson and Bancroft.

On motion of Mr. Bird, a committee of three was appointed, to prepare resolutions on the death of Mr. E. F. Bowditch of Framingham: Messrs. Grinnell, Hersey and Hartshorn.

Adjourned to 2 P.M.

Board called to order by Mr. **Grinnell**, at 2 P.M.

Reports of delegates being in order, the members made report of the societies to which they were assigned, which reports, thirty-six in number, were discussed and laid on the table.

The committee on credentials of newly elected members reported the following: —

Barnstable County, JOHN BURSLEY of West Barnstable.
Franklin County, J. C. NEWHALL of Conway.
Hampshire, L. W. WEST of Hadley.
Martha's Vineyard, N. S. SHALER of Cambridge.
Massachusetts, HENRY S. RUSSELL of Milton.
Middlesex North, A. C. VARNUM of Lowell.
Oxford, JOHN E. KIMBALL of Oxford.
Spencer, EDWARD WARREN of Leicester.
Union, G. C. ROWLEY of Blandford.
Worcester North-west, WM. H. BOWKER of Boston.
Worcester South, G. L. CLEMENCE of Southbridge.

The Governor of the Commonwealth, who is a member of the Board, came in at four o'clock, but declined to take the chair as president, preferring to sit with the Board as a member thereof.

Mr. Grinnell, for the committee to prepare resolutions on the death of E. F. Bowditch of Framingham, late chairman of the executive committee of this Board, reported the following: —

Resolved, By the members of the Massachusetts Board of Agriculture, that, in the seemingly untimely death of E. F. Bowditch of Framingham, a member of this Board, the Commonwealth has lost one of its noblest citizens, the farmers one of their most earnest, devoted and useful co-workers, and we of this body one of our most diligent, delightful and valuable members, whose genial presence lightened our meetings with cheerfulness, and who, by his full acquaintance with all agricultural subjects, his admirable faculty of conveying to others his opinions and the results of his varied experience, and by the sweetness of his disposition toward any differing from him in expression of views, brought activity, strength and harmony into our counsels.

Having acquired a thorough knowledge of all varieties of practical farming, with a mind educated to study and apply theoretical consideration, with a splendid personal carriage, with great individual magnetism, and the capacity of putting himself in ready communication with his hearers in all conditions of life, by his clear, explicit and forcible language, he was one of the most useful members of this Board, not only in our deliberations here, but especially as our representative, addressing farmers' meetings in various parts of the Commonwealth.

By invitation of the Board, Hon. John E. Russell of Leicester, formerly secretary of the Board, and a life-long friend of Mr. Bowditch, offered a warm tribute to the worth and excellence of his friend. He was followed by expressions of respect and esteem from Messrs. Grinnell, Ware, Bowker, Appleton and the secretary. The resolve was accepted, and it was voted that it be spread upon the records, and a copy sent to the family of the deceased.

At 4.30 o'clock the Board adjourned to 9.30 o'clock, Wednesday.

SECOND DAY.

The Board met at 9.30 A.M., Mr. GRINNELL in the chair.

Present: Messrs. Alger, Appleton, Avery, Bancroft, Bird, Bowker, Bursley, Clapp, Clemence, Cook, Cruickshanks, Cushman, Fowler, Goessmann, Goodell, Grinnell, Harwood, Hartshorn, Hersey, Holbrook, Kilbourn, Kimball, Mills, Newhall, Pratt, Rawson, Reed, Richards, G. C. Rowley, J. H. Rowley, Russell, Sargent, Shaler, Shaw, Stockwell, Taylor, Varnum, Ware, Warren, West, Wood.

A committee of three, on assignment of delegates, was appointed: Messrs. Ware, Rowley and Newhall.

A committee of three, on place of holding the public winter meeting, was appointed: Messrs. Hartshorn, Avery and Varnum.

A committee of three, on changes of time for holding fairs, was appointed: Messrs. Kilbourn, Cruickshanks and Bancroft.

A committee of three, to nominate members of the executive committee, was appointed: Messrs. Wood, Bowker and Mills.

A committee of three, to nominate members of the examining committee of the Agricultural College, was appointed: Messrs. Hersey, Clemence and Richards.

A committee of three, on essays for the next annual meeting, was appointed: Messrs. Goodell, Stockwell and Warren.

At 12.30 the meeting adjourned to 1.30 P.M.

The Board was called to order at 1.30 P.M., Mr. GRINNELL in the chair.

Mr. Appleton, for the committee on essays printed in the "Agriculture of Massachusetts," for 1890, reported that the committee, on account of similar matter being before the Legislature, was not ready to report, and asked for further time. The report was accepted as a report of progress, and the committee was granted further time.

Mr. Appleton, for the committee on the World's Columbian Exposition, reported progress. The report was accepted, and the committee granted further time.

Mr. Appleton also reported, for the committee in charge of question of arsenic in wall papers and furniture, that no further action was necessary. The report was accepted, and the committee discharged.

Mr. N. S. Shaler read an essay on "The Inundated Lands of Massachusetts," which was accepted, and will be found printed in this volume.

Mr. Charles A. Mills read an essay on "The Laws of Competition Affecting the Massachusetts Farmer," which was accepted, and will be found printed in this volume.

THIRD DAY.

The Board met at 9.30 A.M., Mr. GRINNELL in the Chair.

Present: Messrs. Alger, Appleton, Avery, Bancroft, Bird, Bowker, Bursley, Clapp, Clemence, Cook, Cruickshanks, Cushman, Fowler, Goessmann, Goodell, Grinnell, Hartshorn, Hersey, Holbrook, Kilbourn, Kimball, Mills, Newhall, Pratt, Rawson, Reed, Richards, G. C. Rowley, J. H. Rowley, Sargent, Shaw, Stockwell, Taylor, Varnum, Ware, Warren, West, Wood.

On motion of Mr. Hartshorn, *Voted*, That a committee be appointed, to co-operate with the Board of Control of the State Agricultural Experiment Station, in the effort to secure proper legislation governing the sale of concentrated feed stuffs under a guaranteed analysis.

Voted, That the election of secretary and other officers be assigned to 1.30 o'clock.

Mr. W. A. Kilbourn read an essay on "The Employment of Farm Labor," which was accepted, and will be found printed in this volume.

On motion of Mr. Bancroft, *Voted*, That Messrs. Wood, Hartshorn, Appleton and the secretary be a committee on legislation.

Mr. J. W. Stockwell read an essay on "The Past and Future of the Board of Agriculture," which was accepted, and will be found printed in this volume.

The committee on place for holding the public winter meeting reported, by its chairman, that the meeting should be held at Spencer. The report was accepted, and the Board voted to hold the next public winter meeting at Spencer.

A committee of arrangements for the public winter meeting was appointed: the secretary and Messrs. Warren, Hartshorn, Kimball, Cruickshanks and Holbrook.

Mr. W. A. Kilbourn, for the committee on changes of time for holding fairs, reported that the time for holding the Attleborough be changed to the third Tuesday after the first Monday in September; the Bristol, to the fourth Wednesday after the first Monday in September; the Hampshire, Franklin and Hampden, to the third Tuesday after the first Monday in September; the Massachusetts Horticultural, to the fifth Tuesday after the first Monday in September; the Middlesex North, to the second Tuesday after the first Monday in September; the Spencer, to the third Thursday after the first Monday in September; the Weymouth, to the fourth Thursday after the first Monday in September; the Worcester, to the first Tuesday after the first Monday in September; the Worcester North, to the third Tuesday after the first Monday in September; and the Worcester County West, to the fourth Thursday after the first Monday in September.

Voted, That hereafter there shall be no changes of time for holding fairs except on request of societies by vote, or vote of trustees, and that notice of such request for change be transmitted to the secretary two weeks at least before the annual meeting, in order that due notice may be given to interested societies.

On motion of Mr. Hartshorn, *Resolved*, That it is the opinion of the State Board of Agriculture that the custom of testing working cattle on the drag at our fairs, as conducted by some of our societies, is cruel and inhuman, and we hereby request every visiting delegate to the fairs in the fall of 1892 to make special note of this part of the exhibition, giving the weight of cattle, weight of the load, distance moved, and other items of interest in this test of working cattle, and report at the annual meeting in February, 1893.

On motion of Mr. Hersey, *Voted*, That the societies receiving a bounty from the State be requested to offer annually to the school children a sum of not less than twenty dollars in prizes for herbariums of flowers, grasses and ferns, and for collections of the different varieties of wood grown in New England.

On motion of Mr. Kilbourn, *Voted*, That the reports of delegates to the societies be mailed to the secretary on or before December 10, and that the executive committee examine such reports, and report to the Board the conclusions of each report, and select such of these reports as contain criticisms or suggestions requiring the consideration of the Board, to be read at the annual meeting; and that any delegate have the privilege of calling up and reading his own report.

The report of the examining committee of the Agricultural College was read by the chairman, W. A. Kilbourn, and was by vote of the Board accepted, and adopted as the report of the Board of Agriculture to the Legislature. The report will be found printed in this volume.

On motion of Mr. Appleton, *Voted*, That the executive committee be instructed to arrange for a field day at the Agricultural College and Experiment Stations, at some convenient time in the year, and arrange if possible with the different railroad companies for reduced fares for those attending.

Mr. W. H. Bowker presented the following resolve, which was adopted: —

Resolved, That the executive committee be instructed to establish a circuit of institutes in this State, to be held one in each society during the fall and winter season of each year, beginning Jan. 1, 1893, under the direct control of this Board, the date and subject to be fixed for each institute by this committee of the Board, after consultation with the officers of each society; these Board institutes to be considered one of the three required by the Board to be held each year.

The committee on essays for the next annual meeting reported by its chairman, H. H. Goodell, as follows: —

Essays.

The Benefits resulting from Agricultural Societies,	Quincy L. Reed.
The Relation of Public Schools to Agriculture,	John E. Kimball.
Going West,	L. S. Richards.
The Horse in Agriculture,	H. S. Russell.

Report accepted and adopted.

On motion of Mr. Rawson, *Voted*, That a committee of five be appointed, to take into consideration any changes that should be made in relation to the holding of fairs, and the advisability of trotting in connection with them, and report at the next annual meeting: Messrs. Rawson, Bowker, Fowler, Hartshorn and the secretary.

On motion of Mr. Varnum, *Voted*, That the committee on legislation be requested to use its influence to secure such changes in the law as may be necessary for the better enforcement of good order at fairs, and that cities and towns maintaining a police force where agricultural fairs are holden shall furnish a proper police force.

At 12.30 the meeting adjourned to 1.30 P.M.

The Board was called to order at 1.30 P.M., Mr. Grinnell in the chair.

The committee to report names for executive committee reported by its chairman, Mr. Bowker, as follows: Messrs. Wood, Hersey, Hartshorn, Rawson and Varnum, who were elected.

It being 1.30 o'clock, the special assignments were called up, and Wm. R. Sessions was re-elected secretary. Mr. Wm. H. Bowker was elected, by ballot, member of the Board of Control of the State Agricultural Experiment Station for three years, in place of Mr. D. A. Horton, whose term had expired.

Mr. Edmund Hersey, for the committee to report names for the examining committee of the Agricultural College, reported the nomination of Messrs. A. C. Varnum and Geo. L. Clemence, who were elected.

On motion of Mr. Cruickshanks, *Voted*, That the present committee on extermination of the gypsy moth be re-elected: Messrs. Shaler, Appleton and the secretary.

The Secretary called the attention of the Board to the report of the Dairy Bureau and to the report of the gypsy moth committee, both of which will be found printed in this volume. He also stated what had been done in the effort to gather and circulate information concerning the so-called abandoned farms.

The Secretary presented a report upon the subject of tuberculosis under the resolve of the Legislature of 1891. After discussion by Messrs. Appleton. Bowker and Cook, the report was accepted, and adopted as the report of the Board of Agriculture to the Legislature. The report will be found printed in this volume.

Mr. Ware, for the committee on assignment of delegates, reported the following: —

Amesbury and Salisbury (Agricultural and Horticultural), ...	G. C. Rowley.
Attleborough (Agricultural Association),	H. Taylor.
Barnstable County, ...	C. F. Fowler.
Berkshire, ...	A. Pratt.

Blackstone Valley,	W. W. Rawson.
Bristol County,	L. W. West.
Deerfield Valley,	I. Alger.
Eastern Hampden,	J. S. Grinnell.
Essex,	Chas. A. Mills.
Franklin County,	G. L. Clemence.
Hampden,	Edward Warren.
Hampshire,	E. Cushman.
Hampshire, Franklin and Hampden,	N. W. Shaw.
Highland,	John Bursley.
Hillside,	L. S. Richards.
Hingham (Agricultural and Horticultural),	A. J. Bucklin.
Hoosac Valley,	N. S. Shaler.
Housatonic,	B. P. Ware.
Martha's Vineyard,	S. B. Bird.
Massachusetts Horticultural,	G. Cruickshanks.
Marshfield (Agricultural and Horticultural),	W. H. Bowker.
Middlesex,	E. C. Clapp.
Middlesex North,	W. A. Kilbourn.
Middlesex South,	E. W. Wood.
Nantucket,	Q. L. Reed.
Oxford,	H. A. Cook.
Plymouth County,	E. Hersey.
Spencer (Farmers and Mechanics Asso.),	G. H. Gardner.
Union (Agricultural and Horticultural),	F. W. Sargent.
Weymouth (Agricultural and Industrial),	Wm. Bancroft.
Worcester,	J. H. Rowley.
Worcester East,	J. E. Kimball.
Worcester North,	C. L. Hartshorn.
Worcester North-west (Agricultural and Mechanical),	J. D. Avery.
Worcester South,	J. C. Newhall.
Worcester County West,	Wm. Holbrook.

Report accepted and adopted.

Voted, That the rule requiring societies to print in their transactions the names of the officers for each year ensuing their election, be repealed.

Voted, That the secretary be required to enforce the rule which requires societies to print a revised list of their members in their transactions, if such list has not been printed within three years.

Voted, That the rule, forbidding societies to publish the dates of their fair before the annual meeting, be amended so as to read as follows: —

"Societies will not be allowed to publish the date of their next succeeding fair without consulting the secretary of this Board, and receiving from him the date which the rule of the Board assigns for such fair."

Voted, That the secretary be instructed to report societies failing to comply with the laws, and rules of the Board, to the annual meeting, for action by the Board in regard to the payment of bounties to such societies.

Voted, That the secretary be instructed to notify the societies of these additions to the rules.

Voted, That the secretary be appointed delegate of this Board, to attend the next fair of the Royal Agricultural Society of England, and that he be authorized to visit experiment farms and stations in England and on the Continent, and make report on the same to this Board; and that he be authorized to use such part of the appropriation for secretary's travel as may be necessary for that purpose.

Voted, That any unfinished business or any new business that may arise before the next annual meeting be left in the hands of the executive committee.

A vote of thanks was unanimously tendered the chairman, Mr. Grinnell, for the happy manner in which he had discharged his duty as presiding officer.

The minutes of the meeting were read and approved.

Adjourned.

WILLIAM R. SESSIONS,

Secretary.

AGRICULTURAL EXHIBITIONS, 1892.

AMESBURY AND SALISBURY at *Amesbury*, September 27, 28 and 29.
ATTLEBOROUGH at *North Attleborough*, September 20, 21 and 22.
BAY STATE (holds no fair this year).
BARNSTABLE COUNTY at *Barnstable*, September 13 and 14.
BERKSHIRE at *Pittsfield*, September 13 and 14.
BLACKSTONE VALLEY at *Uxbridge*, September 27 and 28.
BRISTOL COUNTY at *Taunton*, September 28, 29 and 30.
DEERFIELD VALLEY at *Charlemont*, September 15 and 16.
EASTERN HAMPDEN at *Palmer*, September 20 and 21.
ESSEX at *Lawrence*, September 20 and 21.
FRANKLIN COUNTY at *Greenfield*, September 22 and 23.
HAMPDEN at *Westfield*, September 22 and 23.
HAMPSHIRE at *Amherst*, September 27 and 28.
HAMPSHIRE, FRANKLIN AND HAMPDEN at *Northampton*, September 20 and 21.
HIGHLAND at *Middlefield*, September 7 and 8.
HILLSIDE at *Cummington*, September 27 and 28.
HINGHAM at *Hingham*, September 27 and 28.
HOOSAC VALLEY at *North Adams*, September 20, 21 and 22.
HOUSATONIC at *Great Barrington*, September 28, 29 and 30.
MASSACHUSETTS (holds no annual fair).
MASSACHUSETTS HORTICULTURAL at *Boston*, October 4, 5 and 6.
MARSHFIELD at *Marshfield*, September 14, 15 and 16.
MARTHA'S VINEYARD at *West Tisbury*, October 4 and 5.
MIDDLESEX at *Medford*, September 20 and 21.
MIDDLESEX NORTH at *Lowell*, September 13, 14 and 15.
MIDDLESEX SOUTH at *Framingham*, September 14 and 15.
NANTUCKET at *Nantucket*, September 7 and 8.
OXFORD at *Oxford*, September 20 and 21.
PLYMOUTH COUNTY at *Bridgewater*, September 21, 22 and 23.
SPENCER at *Spencer*, September 22 and 23.
UNION at *Blandford*, September 14, 15 and 16.
WEYMOUTH at *South Weymouth*, September 29 and 30 and October 1.
WORCESTER at *Worcester*, September 6, 7, 8 and 9.
WORCESTER EAST at *Lancaster*, September 15 and 16.
WORCESTER NORTH at *Fitchburg*, September 20 and 21.
WORCESTER NORTH-WEST at *Athol*, October 4 and 5.
WORCESTER SOUTH at *Sturbridge*, September 15 and 16.
WORCESTER COUNTY WEST at *Barre*, September 29 and 30.

REPORT TO THE LEGISLATURE OF THE STATE BOARD OF AGRICULTURE ACTING AS OVERSEERS OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

[P. S., chap. 20, sect. 5, adopted by the Board Feb. 4, 1892.]

The committee to examine the Agricultural College respectfully reports as follows: —

By careful inspection at the annual examination in June, and by still more careful examination of the lands and buildings in August, your committee is convinced that the college is doing good work, and in many respects is well equipped. Still, its motto is "forward," and to keep in advance, with so many rivals, much is needed, and we feel sure will be supplied.

The college is growing in number of students, in the amount of work accomplished, in the improvement of its lands and buildings, and in the influence and acquired position of its graduates. Many of them hold responsible positions in similar institutions, through the United States, and the alumni have no small influence in establishing the name of a college. We were pleased to hear many of them speak so strongly of the good training received at the college as the foundation of their success in life.

We specially value the military drill, improving the health, developing the muscles, and, more important still, preparing each year a body of men fit to become officers in the army in time of need.

We are convinced that the wise purpose for which agricultural colleges were founded is fully justified by the results which we see, and we commend the earnest efforts of instructors and students, to the end that each year may make the college more worthy of the patronage of the State.

The wants brought specially to our notice are: First, a new plant-house, to take the place of one now going to decay. We think it wiser to build new, perhaps a part this year, upon a plan to which additions can be easily made from year to year, as needed. Second, a tool-house and workshop, where repairs can be made. Third, a sufficient supply of manure and fertilizers for the orchards, vineyards, and all the cultivated grounds.

We are urged to recommend the release from the requirement to make the departments, by their sales, in a degree self-sustaining. We think the more nearly self-sustaining they may be made, the better object lesson they give to the students in those methods which every New England farmer holds to be important, though a proper sum may be wisely set aside for experiments and for collections of rare plants. We would make the same rule apply to the farm, so far as possible, leaving to the Hatch Experiment Station the nicer details of many experiments which can only be carried out by nicely separated plots, and continued for a long series of years; and yet we would make the farm valuable to the students and to the State, in confirming the results of these experiments applied to field culture. Such, we understand, is the purpose of the management.

Of the Hatch Experiment Station we are prepared to speak in high terms, — of its comprehensive plans, of the many series of experiments continued through successive years and reaching results which are accurate for the given conditions and which are valuable in general application. Of the experiments made and results reached, the bulletins give full details. We are sure that a visit to the college will well repay any practical farmer, and that the course of instruction there will be very valuable to any of his sons.

The examination of the Class of '91 was conducted in the way that has been the custom from the first. A topic was given the class by the professor of agriculture, and each member required to write what he could. These papers were examined by your committee. The class was also examined orally upon subjects drawn by lot by each member of the class. From the average results of the written and the oral examination the Grinnell prizes were awarded: the first to Malcolm A. Carpenter of Leyden, the second to Henry M. Howard of Franklin.

Respectfully submitted,

W. A. KILBOURN.
GEORGE CRUICKSHANKS.
CHAS. A. MILLS.
A. C. VARNUM.
WM. HOLBROOK.

REPORT OF THE STATE BOARD OF AGRICULTURE TO THE LEGISLATURE. UNDER CHAPTER 118 OF THE RESOLVES OF 1891.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

The Legislature of Massachusetts, at its last session, enacted the following resolve: —

> *Resolved*, That the State Board of Agriculture be instructed to investigate and ascertain the best methods to be adopted in order to protect the citizens of this Commonwealth against the dangers to human life and health which may arise from the presence of tuberculosis in the food products of cattle, with power to employ expert assistance, and report in print the result of their investigations to the next General Court, with such recommendations as they may deem advisable. And for the purpose aforesaid they may expend such sum, not exceeding twenty-five hundred dollars, as they may deem necessary, which sum shall be allowed and paid out of the treasury of the Commonwealth.

In compliance with the requirements of the foregoing resolve, the State Board of Agriculture begs leave to submit the following report: —

This resolve seems to look to a report on two distinct subjects: first, as to the danger to human life and health from the food products of cattle; and, second, as to how best to protect the public from such danger.

First. Much attention has been bestowed by scientists on this branch of the subject, and many thousands of dollars expended by individuals, institutions and societies, in investigation. The Massachusetts Society for the Promotion of Agriculture has expended a large sum in experiments to prove how great is the danger to human life and health, from the use of the milk of tuberculous cows. The results of these experiments were made known to the Legislature of 1891, as were also the discoveries of other scientists in our own and in foreign countries. In view of the results of the experiments obtained at such large expense, the State Board of Agriculture believes that any further experiments and investigations that could possibly be made with the sum appropriated (twenty-five hundred dollars) could throw very little light upon the subject. For this reason no expense has been incurred. That there is danger to human life and health in the food products of cattle affected by this disease, seems to be a proved fact. There is also danger to the life and health of our domestic animals, arising from the presence of these diseased animals among them. How great the danger is, depends on the proportion which the number of tuberculous animals bears to the number of those in health. It must not be forgotten that the danger to life and health is not alone from food products. Many investigators believe that the greatest danger is from the germs of the disease floating in the air. These germs come from the dried sputa reduced to a powder. The same danger arises from the presence of human beings affected with the disease. Many alarmists have stated that the proportion of tuberculous cattle is very large, — some place it as high as twenty-five per cent of the whole number in our State. However, careful estimates from all sources of information show that the percentage of tuberculous animals is very much less than that figure, probably not more than three or four per cent. It is known that the cattle of all countries are subject to this disease, and have been so subject for thousands of years; but it is only recently that it has been recognized as the same as consumption in man. It is not believed that the proportion of affected cattle in Massachusetts is much greater than in other thickly populated countries.

Second. How best to protect the public against the danger to human life and health, arising from the presence of tuberculosis in the food products of cattle. As there is danger, it is highly proper that the Legislature should provide for reducing the danger to a minimum. The trade brings large numbers of cattle from other States to Massachusetts, and there is always a likelihood of infected cattle being brought in. Cattle are always liable to get the disease from consumptive attendants. Consequently we cannot hope to eradicate the disease from among our cattle. So long as the human family suffer from it, our cattle will be liable to it; but it may be reduced to a minimum. The meat of cattle affected with this disease should not be used for food; the milk of tuberculous cattle should not be sold in the market; it is not safe to breed from such animals, and they are consequently worthless. The owners of such animals would be only too glad to be rid of them, were they prevented from selling their food products, and if it were not for the possibility of selling the animal to some one who was not aware of its condition. So the only value a tuberculous animal can have is from the possibility of imposing upon some one by the sale of unhealthy food products or worthless animals. Thus the practical solution of the problem seems to be to find means to prevent the trade in such cattle. Many of the milk farmers of the eastern portion of the State, where all admit tuberculosis to be most prevalent, procure their cows at the Brighton and Watertown markets. There are gathered for sale the surplus cows of western Massachusetts, Vermont, New Hampshire and Maine, as well as many from New York and farther west. A law providing for the inspection of all cattle sold in these markets by a State inspector is recommended. Along with this provision should go an amendment to the contagious disease law, requiring the Cattle Commission to order the slaughter and burial, without appraisement, of animals found to be infected with tuberculosis, in the same manner in which glandered horses are disposed of. Provision should be made for a post-mortem examination of all cattle thus slaughtered, sufficiently thorough to determine whether or not they were tuberculous, and in case the post-mortem failed to show the presence of the disease, provision should be made for remuneration to the owner for the damage suffered.

While the above includes all that the Board desires to recommend, if further provision be deemed advisable, it is suggested that State inspectors might be appointed in different parts of the State, not less than one to each county, whose duty it should be to examine neat cattle on application from the owner, party desiring to purchase or the town or city authorities, and give certificates that such animals were free from tuberculosis when the examination warranted. Provision should be made for the pay of such inspectors from the State treasury per diem for time spent, or by a stated sum per head of cattle examined. In order to make the work of these inspectors most effectual, they should be appointed by and work under the direction of the Cattle Commissioners.

THE INUNDATED LANDS OF MASSACHUSETTS.*

BY PROF. N. S. SHALER OF CAMBRIDGE.

The soils of every country owe their quality to the geological history of the regions in which they lie. They depend for their essential features upon the fact that they are in the main composed of originally substantial rocks, which by processes of decay have been reduced to a fragmentary state, and are now slowly making their way from their original bedding places towards the floor of the oceans. If the rocks whence a soil was derived abounded in materials suitable to the needs of vegetation, the debris which they afford by decay may be fertile, and thus well calculated to serve the interests of man. If the deposits, however, have not such a nature as will afford a nutritious earth, the fields may be barren. Owing to the complicated geology of Massachusetts, the character of the soils, as determined by the nature of the rocks whence they have been made, is exceedingly varied. This variety is enhanced by the fact that in the geological yesterday this region was deeply covered by a mass of moving ice, which dragged the rock waste of one district over the fields of another, sometimes accumulating the debris to the depth of hundreds of feet, again leaving the surface almost without detrital covering.

The character of the soil-covering in Massachusetts is here and there much affected by the varying ease with which the water finds its way from the surface of the land to the level of low tide in the ocean. One of the most important effects of the glacial period is found in the embarrassment of the ancient natural river drainage through the channels of which the rain-water found its way to the sea. Although the valleys of the ancient streams were not to any considerable extent effaced by the glacial wearing, their surfaces were left so beset with the irregularly disposed drift materials that thousands of water basins were formed, varying in area from a fraction of an acre to several square miles. When the ice went away from this district, these drift-formed lakes were far more numerous than at the present day. More than three-fourths of them have ceased to appear as lakes; they have in part been filled by accumulations of peaty matter, in part they have been drained by the cutting down of the frail barriers, a process arising from the outflow of the storm waters which drained from them. In both these cases the original lake has its situation indicated by a soil deposit of a peculiar peaty nature. In certain rare cases peaty accumulations have been formed on surfaces of gentle slope which are underlaid by clay, or other impervious materials of the under earth. In these cases the water has been held upon the surface by the tangle of vegetable growth. In these instances, as well as the foregoing, the defective drainage is in practically all cases due to the alteration of the pre-glacial declivities of the country to a lesser slope, owing to the disposition of the glacial drift.

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The Swamps of Massachusetts.

The fresh-water swamps of Massachusetts are very widely distributed. Reckoning those of all sizes, they are to be numbered by the thousand, and are found in greater or less abundance in every town and city of the Commonwealth. Counting only those of sufficient area to have some importance with reference to the present or future agriculture of the region, the total must be reckoned at an average of not less than a score for each town. A close survey might double this reckoning. There are indeed few farms in the Commonwealth having an area of as much as a hundred acres where patches of the soil are not more or less affected by swampy deposits. Including in the account the marine marshes hereafter to be noted, the total area of Massachusetts lands which are rendered untillable by excessive humidity probably amounts to not far from five hundred square miles, though this total includes some areas which are covered by the shallow waters of lakes. It all may be regarded as winnable land.

It is interesting to note the fact that, while in the cultivated districts of northern Europe the attention of soil tillers has been for centuries directed to the reclamation of these swamp soils, their improvement has received but little attention from our agriculturists. This is true not only of New England but of the most of the other parts of North America. I have estimated that within the United States and east of the Cordilleras we have an aggregate area of not less than one hundred and five thousand square miles of reclaimable inundated lands, and the total for the whole United States may perhaps amount to as much as one hundred and forty thousand miles; while the whole area of such soils made infertile by excessive humidity which have as yet been won to agriculture, probably do not amount to as much as one-tenth of this total.

The reason for the relative neglect of the excessively watered lands in this country is doubtless to be found in the fact that hitherto frontier land might be had almost for the asking, and consequently it was not economical to undertake the considerable outlay which is always necessary in order to subjugate these excessively humid fields of the marine marshes and fresh-water swamps. Now that our frontier lands which are fit for tillage are all in the hands of private owners or of the Indian tribes, our people in their future increase will be compelled to make use of these reserves contained in the inundated lands, or betake themselves to the soils of inferior quality. Fortunately we have complete evidence that these soils in our morasses and beneath the waters of our shallow drainable lakes afford fields of admirable fertility. The experience of Europe before adverted to is upon this point conclusive. The best lands of Great Britain, northern Germany and Holland, and much of those of the excellent quality in southern Europe, were a thousand years ago in exactly the same state as the undrained territories of this country. We may therefore feel sure that in the immediate future our people will find great profit from the improvement of our own over-watered soils.

Limiting ourselves to the inundated lands of Massachusetts, and taking first those which are above the level of high tide, let us note something of the conditions which they present to those who would essay their improvement. From the practical point of view our fresh-water swamps are, in a general way, divisible into two groups: those in which the peat deposit is so thin that the under-soil may, after the construction of drainage ditches and the lapse of time sufficient to induce a certain amount of dryness, be stirred by the plough so as to mingle the decayed vegetable matter with sufficient true soil material to constitute a fertile earth; and those in which the peaty coating is so thick that this immediate utilization of the area is impossible. For the improvement of the first class of soils the prescription is very simple. All that is necessary is to provide drainage ditches of sufficient depth and width and steepness of descent to permit the rain-water, even in heavy storms and in the winter season, to pass away. The sectional area of these ditches and the slope of their floors afford a problem which has to be specially treated for each area. It is worth while, however, to remark that failures in such improvements are most likely to occur where the artificial water-ways are too narrow and of insufficient form. If water is allowed to stand in them during the growing season, they are almost certain within a few years to become closed by the growth of vegetable matter of a peaty nature.

Where, as is the case with most large swamps, the peaty layer is too thick for the direct use of the plough, it is necessary, in order to fit the area for ordinary tillage, to carry the ditches to below the level of the sheet and well into the underlying layers of rocky detritus. When this work has been accomplished, the removal of the peat has in general to be brought about in either of two ways: by awaiting the natural decay, which in a somewhat rapid manner will bring about the destruction of the sheet, or by burning the layer in times of drouth. Where, however, as is often the case, there are fields underlaid by sand, and therefore lacking in vegetable matter, the peat can often be advantageously conveyed to points where it will serve to refresh the soil. Although in certain instances bogs containing thick deposits of peat may profitably be reclaimed, there are reasons why, in the present state of our agriculture, it is not generally worth while to essay the task of winning them to ordinary tillage. In the greater part of our level bogs, particularly those of more than an acre in extent, the peat is commonly so thick that it is rarely worth while to undertake its removal. It is only in the case of the swamps which have a perceptibly sloping surface that the peaty layer is likely to be moderately shallow. Moreover, the deeper bogs are in many cases underlaid by a more or less ferruginous layer known as bog iron ore. This coating, which lies between the decaying vegetable matter and the earth, is often six inches or more in thickness, and more or less completely sterilizes the soil when it is brought into condition for tillage.

The inventive talent of our farmers has already led to the use of a system whereby these deep bogs may be more readily made profitable than by the costly methods required in the complete removal of the peat, such as have been used in northern Europe. In south-eastern Massachusetts a large part of the deep peat bogs have been stripped of their superficial coating of living vegetation, covered with sand and planted with cranberries. Where it is possible to secure a sufficient supply of fresh water to inundate these bogs, in order to protect the flowers and fruit from frosts and from insects, this form of culture has been singularly successful, affording perhaps a larger return on the capital invested than any other form of tillage which has been practiced in the Northern States of this Union. The profits are only, if at all, exceeded by those which are won from the better class of orange groves in Florida. An extensive series of statistics concerning this industry, which I have recently gathered, indicates that the average cost of preparing an acre of bog for cranberry culture, including the expense of caring for the fields until the first full crop is obtained, amounts to about five hundred dollars per acre, and the average net return amounts to between one hundred and fifty dollars and two hundred dollars per annum.

Unfortunately, only a small part of the peat bogs of Massachusetts are in that portion of the Commonwealth where the climatic conditions are favorable for cranberry culture. Experience appears to show that the growth of this plant cannot be profitably essayed in districts north of Boston, or at a distance of more than twenty miles from the shore. Thus, more than four-fifths of the peat bogs in the State appear to lie beyond the limits of this peculiar industry. Although the cultivation of the cranberry seems to be thus restricted, it appears to be an open question whether other crops which tolerate a wider range of climate may not be grown under somewhat similar conditions of culture as the cranberry. It is well known that in the preparation of a bog for cranberry planting, it is the custom to cover the surface of the peat to the depth of about half a foot with a layer of sand, preferably such as may be obtained from a sea beach. In this sand the plants are inserted to such a depth that their roots find it easy to feed in the underlying vegetable matter. Experience, however, shows that the plants will flourish and bear good crops where their roots lie altogether in ordinarily fertile soil, provided the lower part of the layer is kept permanently in a well-moistened state. Although this plant is characteristically a tenant of the marshes, the principal need seems to be permanent moisture rather than any fertilizing effects which the layer of pure peat affords. Substantially the same conditions are required by a large number of our other economic plants. Some of the most successful market gardens of this Commonwealth and of other districts along the Atlantic coast lie in fields which were originally in the state of sloping or shallow bogs, and owe much of their fertility to the fact that permanent moisture is found in a zone at no great depth below the surface.

The foregoing considerations lead me to suggest that our deep peat bogs may afford valuable fields for that important form of intensive agriculture known as market gardening. At first sight the great cost which is necessarily incurred in the preparation of such ground for planting may seem to be an insuperable hindrance to the use of these areas in this kind of tillage. On examination, however, this appears to be a matter of slight moment. A very large part of the existing gardens are upon land which is valued at a price much greater than the cost which would be incurred in improving similar areas of bog soil. Moreover, the cost of preparing such ground for garden purposes would be far less than that required to make it fit for cranberry plantations. For the latter use it is necessary to have the fields so arranged that they may be speedily and entirely flooded, an arrangement which would be not at all necessary in rearing other vegetables. Furthermore, with cranberry bogs it is necessary to have the superficial coating composed of pure sand, in order to hinder the growth of grasses and to limit the disturbance of the tender and entangled vines which the process of weeding entails. Where the field is to be used for the culture of roots and other vegetables, the cost of hauling sand, which often has to be brought from a considerable distance, would be avoided, as any ordinary arenaceous soil would serve the needs.

The principal difficulty which would be encountered in bringing our deep bogs into a condition fit for garden use would be found in the task of mingling a sufficient amount of ordinary soil material with the muck to form a layer of the required depth. It seems to me probable that it would not be necessary to put more than about six inches of sandy matter upon the surface, and to mingle it with an equal amount of peat, to afford an earth which would be well suited, when refreshed with artificial or barnyard manures, for the needs of many plants. The cost of this part of the preparation in small bogs where the sandy earth did not have to be wheeled very far would probably not exceed forty dollars per acre. Owing to the fact that the soft, peaty matter will not support draught animals, at least in its ordinary state, it would be necessary to till the soil with the spade or with traction ploughs drawn by engines placed on the firm ground. This difficulty, however, could in most cases be avoided by lowering the water level of the swamp so that the upper two feet or more of the peat would acquire a tolerably firm character. In the mode of use of the bogs which we are here considering it would be necessary to have the surface of the field frequently intersected by drainage ditches. In fact, these ditches would have to be at a distance of not more than about one hundred feet from each other. This arrangement would probably make it difficult to use any form of plough culture. On the other hand, the very light character of the soil which would be won on these areas would make the labor of overturning the soil with the spade relatively easy.

The advantages which would be gained by converting our horizontal peat bogs into garden grounds would be found in two important features,— in the perfect control of the soil water and the ease with which the soil could be supplied with vegetable matter. Whenever the process of decay had gone so far as to diminish the share of peaty matter in the soil to an undesirable degree, a slight deepening of the tilth would bring up a share of the underlying peat. In the reverse way an addition of sandy matter would correct any excess of muck. It is hardly necessary to state that an artificial soil of this description would have to be continually refreshed by the use of mineral manures. It would have in general the character of the best market-garden ground in Florida, where the earth is composed of peaty matter and pure silicious sand, and where the fertility is mainly contributed by mineral manures which are added from time to time in the measure which experience shows to be required. In the present state of high-grade gardening a soil of this nature, where the moisture and vegetable matter can be accurately controlled, is clearly a desideratum. It is in many cases better to add by precise doses of chemical manures the materials which the crops need than to use the grosser barnyard fertilizers.

The total area of the deep bogs of Massachusetts — those containing peaty deposits so thick that they cannot readily be won to tillage by other means than those above described — probably amounts to more than a hundred thousand acres, and may, on precise reckoning, be found to exceed a hundred and fifty thousand acres. If this great aggregate area can be brought to a state where it will have the value possessed by our better class of market-garden ground, the result would be an important contribution to the resources of the Commonwealth. Although there are many difficulties attendant upon improvements of this nature, the result to be attained is so important as to justify systematic and extended experiments. I have already noted the fact that the methods of cranberry tillage, which are perhaps the most notable contributions to agriculture which have been made in this country, are due to the inventive skill of our Massachusetts farmers. It seems fit that they should go forward with the problem, with a view to determining how far the same or similar methods may be made to serve in rearing other crops. If we can show the way whereby deep bogs may be made valuable fields for the application of high-grade tillage, we shall make the most notable contribution to agriculture which has been won in our century. This improvement would clearly be in the line of our present advance in the tillage arts. We are now trending towards intensive methods of cultivation. To serve the needs of the modern methods, it is in the first place necessary to secure a better control of the water level in the soil and of the chemical constituents of the materials of which it is composed. It is not unlikely that in the immediate future it will be found advantageous to possess areas where the tilled materials afforded by nature consist altogether of sandy matter, to which art will add from time to time the mineral substances which the crops require. Manifestly, these conditions, along with the regulable water supply, can best be secured in the manner above described.

THE MARINE MARSHES OF MASSACHUSETTS.

Along the sea-coast line of this Commonwealth we find a scattered fringe of inundated lands which are winnable to agriculture, and which, as experience shows, may afford fields of great agricultural value. These deposits, which in all cases are surmounted by high tides and laid bare at low water, are denominated marine marshes. Although at first sight these coastal deposits appear to be very nearly related to the fresh-water swamps, they really constitute a very distinct class of our inundated lands.

The most characteristic and important features of the marine marshes may be briefly described as follows: They are formed in the main through the action of certain peculiar species of grasses which have the habit of growing with their roots in ordinary sea water. They are never occupied by arborescent vegetation or by any plants of perennial tops, except where the waters of the sea have been excluded from the field by natural or artificial action. Although the surface of the deposit for some depth below the air may be composed of fibrous peaty matter, there is never any accumulation of the soft muck which is so characteristic a feature in our fresh-water bogs.

As these marine marshes are at many points in process of growth, the manner in which they are formed can readily be observed. The first step in this process consists in the shoaling of the water next the shore by the deposition of sediments borne to the locality by the action of the tide or washed in from the shore, to which is added the material derived from the animals and plants which live and die upon the bottom. Below the level of low tide the accumulation of these sediments or their retention in places which are visited by the currents which generally sweep our shores is in most places greatly favored by the growth of the plant known as eel grass, a singular flowering species which is able to maintain itself beneath the level of the water. The long, slender leaves of this species, growing as they do thickly set upon the bottom, form an admirable network in which the silt swept to and fro by the tide readily comes to rest. When by the process of accumulation the eel-grass flats are lifted to near the surface of low water, they are abandoned by this plant and are seized upon by various species of seaweeds which favor the further accumulation of sediment. When the muddy deposits have attained to a level a little above low-tide mark, the surface is prepared for the occupation of several species of true grasses, which build the characteristic marine marsh.

Beginning next the shore, these plants soon form a fringe of salt-marsh grass land, which quickly grows upward through the accumulation of dead roots and stems, the waste swept in by the tide, and tangled amid the vegetation and the coincident development of many animals which dwell amid the herbage, until the meadow attains very nearly the level of ordinary high tide, after which it ceases to grow upward. The outward horizontal growth of the sheet goes on, however, with conspicuous rapidity. In favorable positions this front of entangled roots and stems, so tough that it can withstand the blows of considerable waves, advances over the mud flats at the rate of three or four inches a year. As the surface of the marsh is thus enlarged, the sea waters which visit it at each flood tide gather into ever larger streams, which keep open certain channel ways by which they find ingress and egress from the widening plain. These creeks are regularly distributed over the surface of the marsh, and have a sectional area proportionate to the amount of water which twice each day courses to and fro through their channels. If the meadow is small, say a few acres in extent, they are hardly noticeable. If, as is sometimes the case, the marshes stretch for miles from the firm land seaward, the larger channels or creeks may appear as considerable rivers.

Experience in this and other countries has shown that these marshes when reclaimed afford soils of admirable fertility. Some of the best lands which have been won to agriculture in northern Europe have been from fields of this description. Unlike the fresh-water bogs, the soil which underlies the layer of fibrous peat does not contain an excess of vegetable matter, and is extraordinarily rich in materials which are most necessary for the growth of economic plants. Experience shows that the fields which are won from these marine marshes will endure the tax of tillage for a generation without the need of refreshment by manure. In fact, the soil is of such a nature that it provides a store of fertilizing material which can be readily brought into the level of tillage by deep ploughing. Thus, while on our true peat bogs formed beneath fresh water the situation affords only an opportunity for securing in the manner before described a soil which may be made a useful foundation for culture, the chemical materials being supplied as the necessity arises, marine marshes afford an earth which is of a permanent and high order of excellence. When properly won to agriculture, they are suited to all the varied uses of field and garden in those cases where very dry soil is not required. As in the case of the improved fresh-water bogs, the marine marshes, when won to agriculture, afford the exceeding advantage of having a controllable water level. Thus they combine about all the advantages which can fairly be demanded of a soil.

The means whereby soils of this nature may be rendered fit for tillage vary somewhat with the circumstances of their position. Where the normal rise and fall of the tide exceeds seven feet the conditions are tolerably simple. It is, in the first place, necessary to exclude the salt water and to permit the egress of that which comes from the land by means of a sufficient dike or dam, provided with flood gates which close at the time of the incoming tide and open during the later stages of the reflux. The site and conditions of this dam afford engineering problems which have to be dealt with according to the local conditions. In arranging this barrier it is necessary to provide for the storage on the land side of the water which may be brought down by the rivers during the time when the flood gates are closed, in order to prevent the inflow of the sea water. This can generally be accomplished by placing the dam in such a position that there is a large sectional area of creek channels enclosed in the reclaimed district. The next step after the outer dike is constructed is to ditch the ground so that open trenches may be provided in such manner that the soil water is maintained at a sufficient depth below the surface. In general it is desirable to have these channels not more than a hundred feet apart. Although it is best that they should be open ways until the first desiccation of the soil is accomplished, they may afterwards be brought into the condition of ordinary tile drains. Before or after the drain ways are cut the surface soil to the depth of the fibrous peat should be overturned by the plough, in order to kill the natural growth and to favor the leaching out of the salt from the superficial parts of the marsh. It commonly requires about two years to secure a sufficient removal or decomposition of the salt to fit the soil for crops; but after a year the fields, if the artificial drainage be made deep, may be planted with rye, which will sometimes yield a crop. It often happens that an incrustation of salt forms on the surface of the ground, but this is readily destroyed by ploughing.

For the first few years after the tillage of these reclaimed soils of the marshes is undertaken, culture is made difficult by the presence of the fibrous peat, which is slow to decay, and by the excess of salt. Under favorable conditions, however, these fields can be brought into an excellent state within three years from the time when the sea water is excluded from them. At the outset it is best to maintain the surface in plough tillage, preferably with root crops. A little later the earth becomes well suited for the growth of herd's-grass and other forage plants. It appears likely, however, that red-top is the best suited to these areas which have been recently won to tillage. If the fields are left for even a few years without ploughing, they are apt to become occupied by a growth of bushes and low-growing trees, such as our white birches. It is therefore desirable to push forward the operations of tillage as rapidly as possible. When fairly won to use, these fields of the marine marshes may, on account of their very large returns, the ease of the culture which need be applied to them, the absence of all need of artificial fertilizing and their nearness to great markets, be fairly reckoned as worth two hundred and fifty dollars an acre. Under favorable conditions they can be brought into satisfactory shape at a cost of about one hundred dollars an acre.

The total area of these marine marshes within the limits of Massachusetts appears, from the estimates I have made, to be about ninety thousand acres, of which probably more than one-half can readily be won to tillage. The size of the fields varies from that within Plum Island, which contains ten thousand acres, to innumerable smaller areas, each less than ten acres in extent. A list which I have made, which includes no fields of less than thirty acres in extent, amounts to more than one hundred and twenty; including the areas of more than five acres in extent, there are probably as many as five hundred distinct fields within the limits of this Commonwealth, of which about a dozen contain a thousand or more acres. It is therefore evident that these land reserves are of the utmost importance to the future of our agriculture.

So far the only considerable effort to win these marshes to tillage has been in the town of Marshfield, where, a number of years ago, an area of about fifteen hundred acres was diked off from the sea. Unfortunately, litigation and even violence has delayed the work of bringing the greater part of this area under tillage, yet the results show the admirable fertility of the soil. Fields which of old gave only scanty crops of marsh grass now yield very large returns of hay and root crops. Imperfect as this experiment has been, it serves to assure us as to the great possibilities which are open to drainage processes of this description.

(For further information on this subject of marine marshes, see preliminary report on the sea-coast swamps of the eastern United States, by N. S. Shaler, sixth annual report of the director of the U. S. Geological Survey, pp. 353–398, Washington, 1886. For further information concerning fresh-water morasses, see general account of the fresh-water morasses of the United States, with a description of the dismal swamp of Virginia, by N. S. Shaler, pp. 255–339, Washington, 1890.)

THE PAST AND FUTURE OF THE BOARD OF AGRICULTURE.

BY HON. J. W. STOCKWELL OF SUTTON.

I shall give no historical sketch of this Board. It lives in its results, not in its years. It asks no veneration for its long life; it only asks that intelligent meed of praise that its past record compels all to acknowledge who have studied its beneficent course down to the present time, and its greatest encomium is in an intelligent survey of its results.

> "And 'tis a kind of good deed to say well;
> And yet words are not deeds;"

but in this Board, word and deed, precept and practice, theory and experiment, harmoniously interwrought, have accomplished their best returns to the agriculture of the State.

No task I ever undertook became so interesting and enticing; it has called up to memory's gaze so many of the good old members, recalling their forms, their words, their looks and their works, till the pen has fallen from my hand; the essay has been forgotten, and I have been lost to everything but the charm of the delightful reminiscences of the times and associations of the past.

If my pencil could picture in words a tithe of the tribute of my heart, I would indeed be glad; as it is, I bring to this grand old Board my last wreath, hoping that in it may be found an immortelle or two, and lovingly place it on the brow of this Massachusetts Board of Agriculture.

When the morning sun gilds the eastern sky there is no perceptible change observed either in the atmosphere or in nature, and no great change comes at any one moment to mark the influence of the sun's rising; yet we see gradually the mists disperse, the vapors of night flee away, and the warmth and joy and life of the summer's day gladden the land and give strength and vigor to our hearts. Our pulses throb with delight, and we rejoice with all nature because another day is born into the world, and the sun still sends forth his beneficent beams to gladden, to beautify, to fructify the earth; and yet it has all come about so gradually, so quietly, so silently, that none noted the forces, but all appreciated and rejoiced in the result.

Such has been the influence of the Board of Agriculture of Massachusetts. We cannot turn our investigation in any direction but we find the influence of this Board has, or its strongest members have, been before us, enriching the whole circle of our varied industries, and nature's storehouse is enlarged to us by its investigations.

Range through the series of domestic animals, the horse, the cow, the sheep and the swine, and mark the progress in each department.

The plodding horse, bred without method, aim or object, has given place to the Morgan and to the Hambletonian, to "Dictator," "Electioneer" and "Alcantara;" and so sure is the pace secured that the foal has its price assured while it is by its mother's side; or for draft the Percheron, or for strength and the road the French coach horse. Then in the care and handling of horse or colt what a change. The mongrel colt, with his often ugly disposition, broken in — and broken down — when three or four years old, has gone never to return. The cruel treatment, the harsh methods that rendered intractable and often frantic the timid animal, have given place to gentle treatment and reasonable, instructive training. So the horse of to-day is another creature; he is bred to intelligence, and intelligently.

Then the cow, strange to say, one of the last to be understood and her qualities determined. Strange, because she is so closely connected with the profits of the dairy and the comforts of the home. Even now the light is just breaking upon the farmer's vision, and the profit he secures or the loss he suffers is brought directly to the animal, without mistake or possibility of injustice by new and simple methods. By them the dairy value of each cow is determined, and this at the slightest expense either of money or time, and by a simple process that any farmer can use. This is one line of aid to the farmer that the Dairy Bureau will demonstrate during the present year, and this instruction and demonstration will be of incalculable benefit to the dairy interests of Massachusetts. This is aside from my subject, perhaps, but its importance justifies its introduction.

The history of this Board is full of instruction to the farmer in this important dairy department, and its results are plainly seen: till to-day it is the exception when you find in our herds or on our hill-sides the old general-purpose cow or no-purpose cow, with the greatest capacity for food and the least for milk, cared for and retained because, forsooth, she has a good carcass for beef when killed. Here kindness is its own reward, and unkindness preying on her nervous organization is its own punishment. To-day the cow is a petted animal, must I say because gentleness has a money value? No, I will not, for I do not believe this to be the chief reason. Kindness has been from the first a fundamental teaching in this Board.

And with the sheep, the importation, the encouragement, the improvement in breeds, management and profit, are largely due to this Board, and a prominent part of its work, with excellent results; and if after all much of our labor has "gone to the dogs," it is not the fault of the Board.

And last the swine. How different the breeds, the treatment and the resultant profit. The great coarse hog, burrowing in filth for one and a half or two years, eating himself up once or twice over, is past, and we have in his place the clean, small-boned, fine-fleshed pig, hastened to market at just the point of greatest profit. In all these changes the Massachusetts Board of Agriculture has been a pioneer worker, a potent factor; and its country meetings, its institutes, its lectures, its reports, have carried the leaven of its teaching to every farmer's fireside in the State, and who can compute its influence?

Now turn your eye to the vegetable, the grain, the fruit and the flower; and first in every department, creating, enlarging and transforming, is this same old Board,—creating new and greatly better varieties, enlarging by scientific and sure knowledge, multiplying by skill and experiment, until guess-work has given place to fact, and we know that whatsoever a man soweth he shall reap just in accord as he follows nature's laws; transforming by hybridization and skillful nurture till "the little one has become a thousand and the small one a great nation."

I challenge comparison with any other Board, State or National, to bring results so varied, so beneficent, so lasting, so practical for the good of the common people of the State as this Board of Agriculture of Massachusetts; and the names of Wilder, Moore, Flint, Bowditch and many others, creators in their lines of work, will never be forgotten. I do not claim for it the original patent to every advance, but I do claim that it has been so quick to discern, so patient and conclusive in experiment, so earnest to seek, so urgent to urge the new and the better, and so careful and sure in its conclusions, that it has held the confidence of the farmers of this State with unvarying faith to the present moment.

And not alone in the field of nature in its several departments has its influence been most potent and beneficial to the farmers of this State, but it has gone into the homes, and added beauty to them; it has studied the roads, and sought to improve them; it has glanced at the roadsides, and they have become more attractive; in the surroundings of the home it has encouraged beauty, fragrance and refinement; in the garden comforts and delicacies unknown before, giving beauty to the eye, pleasure to the palate, and attractiveness to rural life.

Though we have another organization working in perfect accord with this Board, whose special work is more in the line of the attractive home, the social life and the development of the intellectual powers, in which many of us are true workers, we gladly turn to this old Board, and acknowledge our obligations to its earlier sowing of the seed and its present labors in this important mission to the farmer of Massachusetts. These two, working together, have given a new incentive to toil, have brought heart and soul into the life of the farm, and enlarged the intellectual scope of the farmer's vision, until to-day the agriculturists of

Massachusetts are not in any line a dependent class, but strong in sturdy strength to cope with any other, and able to care for their interests and maintain their rights as never before in the history of the State.

This Board was largely instrumental in establishing the Massachusetts Agricultural College, and, when the United States grant of land scrip was made, at once took hold of the task, and its influence was given to its establishment on a firm basis. The Legislature recognized this work, and made the Board of Agriculture overseers of the college, and its committee is continued to the present time.

In 1879 the Agricultural College would have been buried in darkness and its funds merged in the Amherst College, only for the indefatigable efforts of members of this Board. I speak that I do know and testify that I have seen on this matter. It was my fortune to serve in yonder Senate, and to be chairman of the agricultural committee. Another member of this Board is present here to-day who helped in that struggle as chairman of the same committee on the part of the House. *We* know the valuable work done by this Board at that time, and the wisdom of counsel that saved, when, could one straight blow have been struck, the doom of that college had been sealed. "It was an hour of fearful issues," and but for this Board all had been lost. How careful our watch, how unwearied our work, how wise our secret counsels, none will know; but the college was saved, — saved to its appreciated and useful present, and to its enlarging, unfolding and glorious future, benefiting not the State alone, but the nation and the world; her graduates prominent in every department of agricultural science, in college work successful, whether in our own country or piercing the "light of Asia" with agricultural knowledge. And, let me repeat, it was the influence of this Board, the education emanating from this Board, the work of members of this Board, that gave it lease of life in that trying hour. And this should not be forgotten when you deal with its past and try to measure its influence.

Let me name only two or three of those members whose work was unremitting and most effective.

Hon. Marshal P. Wilder: how well I remember him, toil-ing up the steps to the Capitol day after day, to argue, plead, beg, even, for the life of the school, till one luckless morning he fell and fractured his hip; but pain did not hinder, and from the sick-room came the messages, and to the sick-room were called the friends, and the work went on.

Not less earnest or effective was the work of another member, Hon. Wm. Knowlton of Upton. They were true yoke-fellows. His work for the college began long before, and his liberal heart had met every emergency in college finance, and his faith never wavered through those dark days, — the result perhaps in part of its own rashness and mismanagement.

And yet one more, — the first secretary of the Board, — Hon. C. L. Flint: watchful, careful, clear, concise and ready, strong in debate when aroused, patient when necessary and impetuously bold on occasion, he was a capital sentinel on the wall at this time.

And now they each rest, — their work is done; but the college lives its yet young, strong, enlarging life, — a circle of widening influence; and who can scan its boundaries or gauge its influence? — not the historian of to-day, surely.

So of us all; we change, we pass off this Board, but the Board lives, and never was its influence greater, or its prospects brighter or more fraught with possibilities of good to the agriculture of Massachusetts, than to-day.

The service rendered by this Board in the successful campaign against pleuro-pneumonia was a striking example of its courage as well as of its wisdom. This disease appeared in 1859, and the attention of the public and the Legislature was called to it by the secretary's report; the disease was described, the great danger to the cattle industry not only of the State but of the whole country was tersely pointed out, and the Legislature called upon to give the necessary authority and grant the money needed to exterminate it. Led forward and urged onward by this Board and the commissioners, the Legislature was brought to realize the emergency, to furnish the money, to enact comprehensive laws that gave power to the commissioners, and the disease was stamped out. These commissioners in their report say: "The commissioners are happy to be able to acknowledge the services rendered them by the Massachusetts State Board of Agriculture. Its secretary, Chas. L. Flint, was found ready at all times to afford any assistance and encouragement in his power, and attended personally at many of the post-mortem examinations. The State Board appointed a committee of three to advise with the commissioners, and devise with them the most active and efficient modes for carrying out the objects of the commission. Their advice and co-operation during a most pressing period were of the highest value to the public."

This Board was the first to take cognizance of the frauds in commercial fertilizers, and urge the enactment of a law regulating their sale in the State, — one of the first enactments of the kind in the country. It was a needed law. The fraud in fertilizers was depleting the farmer's pocket, and discrediting science. The secretary of this Board was first to see it and prompt to propose the remedy, and other States followed the good example.

It is well, on this fortieth anniversary of the organization of this Board, to recall the past, as we have done, to glance at the changes wrought and to call up these incidents to its praise. The strictly historical sketch let another write, perhaps one who has been with it and of it almost continuously from the first,— a chapter from his own life's history, — while we look the present in the face, and "without fear and with a manly heart" look into the future. Says the eloquent patriot, "I know of no way of judging the future but by the past;" and in the fulfilments of the past this Board may well feel assured that the State will place on the department no labor it cannot perform, or the Board assume responsibilities beyond its powers, or adopt new methods until wisely considered.

The present seems to be a transition period, from advisory and educational to executive; and the Legislature and the Executive of this Commonwealth recommend and confidently place on this Board weighty responsibilities and enlarged powers. There are naturally diverse opinions as to the wisdom of these changes; and, while the workings of the new boards thus far have been all that the most critical friends could desire, and while the prime idea of centralizing the agricultural interests in this Board is conceded to be wise, and the desire that the executive officer of these bureaus should here be found is expedient, it is questioned whether the future of the agricultural work bound up in and confined to the forty men herein represented is wise and for the best interests of the agriculture of the State; in other words, it is universally conceded that the secretary of this Board should be *ex officio* the executive of these various commissions or bureaus that should centre here, but it is not conceded that better service will be found or stronger and abler counsellors obtained out of this small number than out of the larger field,—the State.

It is not conceded, I think, that gratuitous service is better or more honorable than is properly and fairly paid service, or that such a gratuitous service is as creditable to the prosperous State of Massachusetts or to the body that accepts such service. It is not conceded, I think, that the agriculture of Massachusetts is receiving such aid from the State as calls for such sacrifice on the part of this Board, or that it is best this method so undemocratic should prevail to the exclusion of the practical farmer who cannot afford and therefore will not accept these positions, though perhaps in all respects admirably fitted for the duties.

It is not conceded, I think, that a Massachusetts member's usefulness on one of these commissions will be destroyed, lessened or impaired by an agricultural society refusing to re-elect him a member of this Board, or that the short term of office that must necessarily follow from confining the service to the short term on this Board will be to enhance the value of the service, or accrue to the benefit of the State; instead, has it not been found that on this Board the best results have been obtained from continuity of service and experience in the work? As the position becomes more important, and ts duties require more wisdom and more skill, the reasons for continuance multiply, and the worth of experience is more apparent and conclusive.

It is not conceded, I think, therefore, that the agriculture of the State will not suffer loss by these changes, when you go beyond the principle of centring in this office the work, and making your secretary the executive officer in each bureau, and the Executive of the State or the Board of Agriculture to select such members as shall be best for the work assigned, whether it be within the Board or within the State.

I am not prepared to subscribe to the idea that there are too many of these societies. I have given this matter careful observation and much study since these inequalities were suggested, and my conclusions lead to an opposite result. I find that where there are the most State societies there are the most town societies and farmers' club and grange exhibits, and here are found the finest and most instructive fairs. And, again, just where you find the abundance of these societies, there do you find the most progressive and intelligent agriculture, the most prosperous and contented farmers, the finest products, the best herds and the most improved methods, and the most happy homes. We shall take from agriculture when we take from the pride in success, and the emulation in our work induced by these frequent exhibitions in which comparisons are made and methods studied. Neither is there any lack of attendance at any of our fairs, instead, an increase in numbers and an increase in interest.

Again, it is wrong to take from the farmers these happy re-unions and joyous occasions looked forward to with bright anticipations and remembered with pleasure. The flowers grow to add beauty to them; the tidies we men so love, and the wonderful crazy quilt, are wrought in the quiet evening hours with bright anticipations of these festivals. Take away the annual fair and substitute a scientific school in its place, — the man who would do this knows nothing of the solitude and self-denials of the poorer rural home to which this autumn festival comes with a brightness he cannot appreciate.

It is a misguided policy that would take away one of these festivals or take from them one of their innocent pleasures or amusements. We stand before this Board and boast our delight in horse-trotting and the running horse, and with the folly of pretended morality shut out the farmer and the farmer's family from the same pleasure, because they cannot afford to enjoy them *except at these fairs.*

A few years ago there was a raid on fiction in our public libraries, and it was claimed that they should furnish only the instructive works, — science, history, essays and travels; and what was the result? The libraries were largely deserted, and the mistake was demonstrated. There are those who propose improvements in these exhibitions just as fatal to their usefulness and their very life. Let us not, therefore, abridge the number or the pleasure of these occasions. We may lay down rules or enact laws, they will be useless, — with or without the State's aid the farmers will have these festivals, and they will gain instruction from them. On which day of the cattle show in any section of the State is the larger attendance? Not a society is an exception to the rule. The horse has a legitimate place, and speed has a legitimate place, at the fair; and I would oppose giving the bounty to any society that did not in some proper way encourage speed in the animal. We have one society in this State conducted on this so-called higher plane, and its two exhibitions have been financial failures; and here is the chance and the opportunity to demonstrate the value of these theories before you tear down the old and tried success of the present method.

As in the case of the library, it is a fine-sounding theory but a fallacy in practice; and this Board ought to have learned it ere now, and settled its policy without these periodical spasms after a mistaken "higher life."

I am not yet prepared to endorse any proposition that shall leave any society to which the State's bounty is given without representation at our meetings. It is a duty the society owes to the State, in return for the aid received, to send one of its best representatives and most prominent members to aid in our consultations and counsels for the best interests of the society. It is right they should be present to explain conditions, to answer criticism and to make known the peculiar and individual surroundings which often lead to diverse methods in the conduct of our fairs to bring about the best results. It were well that some method should be adopted to impress on these societies the importance of their selection and the obligations they are under to secure their best men, and, having done so, to retain them. These frequent changes are a loss to the society and a greater loss to the Board.

I do not mean by this to be understood that intellect is all that is needed, or the criterion of usefulness, or that one class should obtain to the exclusion of the other. The record of the Board proves the safety and the advantage this mingling of interests, practical, experimental and scientific, has wrought, — the strength of a triple cord that cannot easily be broken. Therefore, in view of the work of the past, who shall say which were the more necessary to the best interests of this Board or to its broadest influence on the farming of Massachusetts, — the professor or the farmer. The one takes his results from science, the other from observation and experience; the one from the laboratory of scientific knowledge, the other from the laboratory of nature's alchemy; and so, working together, the conservation of truth is found and preserved to bless the State and the country.

True, "Gold and meal are measured otherwise;" but who shall say which is the more important; or where shall the professor's knife be drawn to cut away the farmer; or where shall the farmer's sickle be thrust in to exclude the professor, or count his work as needless?

Only a few years ago it was the work of this Board to induce the farmers to accept and adopt the deductions of science. The farmer was slow, and he had reason to be, for under that name he was cheated on every hand; and fertilizers that did not fertilize, attested by chemists who betrayed science for gold, were preying on his very life; but to-day he has learned the lesson well, and he gives the professor who has toiled for his benefit sincerest praise and honor. But let not the other decry or put out from this laboratory of Massachusetts agriculture the practical common-sense or the strong right arm of the working farmer, lest the Board receive detriment to itself. Together they have given it strength, and together let them stand to conserve its future power.

The recommendations of his Excellency the Governor of this Commonwealth in reference to this Board are favorably received and generally commended. It is pleasing to find the Governor of the State and president of this Board so observant and well prepared to outline and present before the Legislature recommendations so clearly defined for the improvement of this Board and for the benefit of this prime productive industry. It evinces an interest in agriculture and a study of its needs and a desire for its improvement that is most welcome and most opportune. The only difference of opinion in the Board to-day is in details, — the general policy as outlined by his Excellency is endorsed.

In the same desire for the future of this Board and in the same spirit of loyalty to agriculture, I shall venture to repeat a few suggestions already brought to your attention, touching only minor details in working out the grand idea of centring all the interests of agriculture in one department and under one control.

I realize in this stirring age the attractiveness in opening out new vistas and developing new departures from the old paths, and how easy it is to undermine the old and tear away its foundations, and to build ideal structures in the mind's eye. But, instead, it is our work to make the perfect joint so nicely fitting and interlacing in such perfect accord that the sound of the hammer shall not be heard to mar the harmony or interrupt the work. This is our aim, and it is well that we "haste not, waste not," but found the principles in assured fact and experimental knowledge, building the superstructure upon such strong foundation as will stand to our credit and to the success of this old Board. A mistake may seriously retard, while slower progress will not endanger, our advance. I do not counsel delay, only that we study these questions and proceed along the lines marked out, carefully guarding our every advance, that no retreat shall be possible till we hold the farmers' interests, now scattered among other boards, centred in our hands for the best good of the agriculture of the State.

Some of these boards are doing excellent work, and must be highly commended, — their record praises them, — doing better work, perhaps, than could be accomplished at first under the proposed system. Others treat our most vital interests as subordinate, and give them only second place and meagre attention, and require apologies if we encroach upon their valuable time with inquiry or suggestion. *These* *demand change.* To do this successfully requires wisdom, prudence, sagacity and time. But it is to come, and it is just before us, and we may not delay these changes lest we do injury to the best interests of this department we are set to guard.

I have said that it might be more difficult to find the best men within the circle of this Board than in the larger sphere of the State. I think this a very important consideration, and therefore propose that, associated with the secretary of this Board as the executive officer in these departments, by appointment of the Governor or by election of this Board, or by joint action, the Governor appointing the chairman and the Board electing his associates, shall be three persons to constitute the Bureau, *and these shall be by virtue of their office members of the Board of Agriculture.*

This will give continuity of service to the bureaus, and take away the great objection of frequent changes that must result from confining these labors to the short terms that prevail by the present policy of the various societies. This method will slightly enlarge the Board at first; but, as the societies learn the need of the very best men in this enlarged work, and the benefit to agriculture from the selection of them, they will elect with more care, and retain in the service longer than heretofore, giving to the Board more permanency, stability and character. This will lead directly to selection both by appointment and election (if such should be the way provided), coming more frequently from the members, and by their retention by the societies they represent. If the societies do not learn wisdom, it will guard against too frequent changes, and the loss of valuable service at the point of its highest usefulness and greatest utility to the especial department.

Under this system the Board gains in effective strength, the department in special efficiency and the State in service.

And, second, give to the members of these bureaus fair compensation for time actually employed, and the expenses necessarily incurred. As I have before suggested, it seems to me neither right nor business that the State should demand or receive from the members gratuitous service. Let the compensation be so low that the positions shall not be unduly sought, but not so meagre that good service cannot be obtained. It will not result in injury to the service, but in its improvement and greater efficiency.

These questions are coming before you for your decision in the near future, and I do not fear but that the result of your deliberation will be wise, and for the best good to the farming interests of the State.

The Board that has done so much for the Agriculture of Massachusetts, and foreseen so wisely its best good on the great questions of the past, will make no mistake now or in the future. Whatever your conclusion and your action, I have such confidence in your practical wisdom that I confidently predict that the historian of the half-century of your work will with pleasure write, as I have written, of this fortieth year, finding naught to criticise and much to praise.

THE LAWS OF COMPETITION AS AFFECTING THE MASSACHUSETTS FARMER.

BY CHARLES A. MILLS OF SOUTHBOROUGH.

By competition is meant "The act of seeking, or endeavoring to gain, what another is endeavoring to gain at the same time." The survival of the fittest is a terse expression of the same idea; superiority in reaching a given end is shown by competition.

The stage coach for many years knew no rival as the most expeditious and convenient mode of travel; it struggled for existence after the railroad had set up rival claims, but at last was compelled to yield unlimited sway to the swiftness and comfort of its competitor. In this case invention wrought the change.

The wharves at Nantucket not many years ago were crowded with vessels engaged in capturing the whale. The introduction of petroleum, however, left little room for doubt as to the superiority and cheapness of kerosene as compared with its dingy rival; and so these same wharves are left to idleness and decay. Here discovery wrought the change, and benefited the many at the expense of the few.

Sometimes this law is wrought out in a brief space of time; again, like the mills of the gods, it grinds slowly. Last autumn the foot-ball eleven of Yale met their opponents of Harvard upon Hampden Park; after the ball was in motion, it took Yale but fifteen minutes to decide the contest. Here force, pluck, and skill were all brought into play to decide the battle.

The laws of competition as affecting the farmer's vocation are less rapid in deciding the victor, but are equally sure. The farmer is not exempt from these same laws; invention, discovery, force, skill, — factors which are brought into play to decide superiority in all lines of production, — have had their effect upon Massachusetts farming. It is my purpose to discuss briefly some of these principles, and, if possible, to reach wise conclusions.

The early history of farming in New England was a struggle for existence itself. Our forefathers contended with a rigorous climate, a rough if not unfertile soil, to cultivate which only the rudest implements were at command. The simple necessities of their homes were meagrely supplied by their own handicraft. Those were the days when the scanty harvest of grain was made ready for the kneading bowl with the pestle and mortar; the spinning wheel and hand loom prepared the material for a scanty wardrobe; exchanges of product were infrequent; the farmer sold little and bought but little; the laws of supply and demand had but narrow play to cause either a glutted or a depleted market. In those days not even the fertile valley of the Genesee had commenced to yield its abundant harvest, much less the vast acreage beyond and beyond, that, step by step and acre by acre, has responded in continually increasing harvests to the touch of the eager settler.

It is not my purpose to discuss at length the causes that have wrought this wonderful development; the laws of competition themselves, in a country enjoying the political liberties and natural resources of the United States, have been the mainspring to set every wheel of industry and improvement in motion. Banish from our thought for the moment every other line of effort but the farmer's, and even here we are amazed at the improved mechanical power put into his hands to cheapen and increase the products of the soil. The wooden plough, that with slow and toilsome furrows imperfectly turned the earth, has given place to implements that automatically and almost perfectly prepare the soil for the seed. In this first agricultural step, the present effort of one man equals the labor of ten in the olden time. The mower, the reaper and binder, the thresher, the centrifugal separator, — these and many more implements of skill, though lightening the farmer's toil, have at the same time multiplied his producing power, and have thus not only filled to repletion our own markets, but have furnished a surplus for exportation. Not only has the power of production been multiplied, but cheapness and rapidity of transportation have placed the products of what seemed but yesterday the vast unknown at our very door.

The policy of our government has been this: first, to build the railroad; then to say to the nations of the earth, "Come to us; buy a ticket over our road, and a farm is waiting for you at the end of your journey at your own price." The Swede, the Norwegian, the Pole, the German, have flocked to these lands; neither forest nor stones have delayed their occupancy. These people have lived upon the barest necessities of life; the log cabin or dug-out is the home, while a pair of horses, a plough, and a harrow constitute the equipment. They are able at once to cast the seed into land rich in plant life. The Massachusetts farmer stands but small chance to meet competition in the products which this settler can put onto our markets and obtain the same price as those grown here. It is cheap land pitted against lands that but recently have commanded a large price; it is land of abundant richness as against that in which the nitrogen, potash, and phosphoric acid have become exhausted. In animal industry there is the advantage of a mild and almost winterless climate, as against our long and rigorous winter. If large capital is invested, it is pitting the wholesale producer as against the small retail grower. It is matching the expenses of the rudest and simplest mode of living against the rightful demands of a Massachusetts home.

It is often asserted that, if our farmers would live as frugally as our forefathers did, they might accumulate money. They have no right to be content with any such mode of living. This is an age of progress in the things that contribute to man's well-being; the farmer not only has a right to a place in the procession, but should demand it.

From a broad and patriotic stand-point (the true point from which to look), this policy of our government has doubtless been wise. Should not all patriotic citizens rejoice at the size and productiveness of Uncle Sam's farm, stretching as it now does with an almost unbroken furrow from the Atlantic to the Pacific? Abundant food must ever be a potent factor in the onward march of a nation's prosperity.

In a narrow sense this policy of free land and cheap transportation has borne hard upon some lines of New England farming. It has compelled us to face a constantly decreasing value in our lands not situated near to centres of population. Some lines of production once profitable we have been forced inch by inch to relinquish to those more favorably situated for producing the same product. This is forcibly illustrated by the beef industry, which forty years ago formed one of the corner-stones of profitable Massachusetts farming; to-day, excepting as a by-product, it has ceased to be a factor for intelligent effort. The agricultural census of 1885 gives the number of pounds of beef produced that year in Massachusetts as 10,668,941, while in 1865 it was 70,825,396; these figures indicate a decline in this product of over 80 per cent in twenty years. Can this shrinkage be explained upon the ground of decreased demand? By no means. Our increasing population has called for more and more of this product; every freight train entering our portals from the West has at least one car labelled "Chicago Dressed Beef."

The question is raised why our sheep industry shows constantly diminishing returns. If eloquence from gifted members of this Board could stem the ebbing tide; if the example and teaching of one so wise, so beloved (around whose fresh-made grave we stand as mourners to-day), could convince our farmers of the desirability of calling back to these brush-ridden lands the prodigal flocks, — then long since would this industry have been quickened and revived. In 1865 our production of mutton was 8,989,506 pounds, in 1885 954,179 pounds, — a shrinkage of 89 per cent. Of wool we raised 610,255 pounds in 1865, in 1885 257,544 pounds, — a loss of 57 per cent. The loss in our pork product follows the same law, although the decline is not so rapid. No known law can completely drive the hog from our midst. In 1865 the census shows a return of 29,440,447 pounds, in 1885 16,546,752 pounds, — a loss of 43 per cent. Beef, mutton, wool, and pork show a marked decline.

How have our cereals fared at the hands of Western competition? In 1845 Massachusetts raised of cereals, exclusive of corn, 1,887,275 bushels, in 1885 988,952 bushels,—a loss in forty years of 47 per cent. Corn in the number of bushels grown has more nearly held its own; its value has shown marked decline. In 1855 we produced 2,595,096 bushels, valued at $2,820,109; in 1885 2,147,390 bushels, valued at $1,271,349. Most of the corn raised in our State, and many thousand bushels besides, are fed by our dairymen to their milch cows. Although saving the purchase to the extent of its value, it can hardly be considered as affording a direct money return, since but a very small amount is exposed for sale.

It will be observed that all of the above products — beef, mutton, wool, pork, the cereals — can be transported long distances without deteriorating in value. And here let me say that the loss in these products accounts for most of our abandoned farms, for these forsaken lands when tilled were largely devoted to raising these same products.

These farms from a sentimental stand-point cause "The tear of regret to intrusively swell," but from a business stand-point they proclaim that more and better results can be obtained elsewhere with a like amount of effort. The herculean labors put forth in the early subduing of many of these now forsaken homes awaken admiration for heroic men and women. Alas! that the depletion of these lands by wasteful husbandry should have so soon followed. At the present time, to continue the struggle along the same old lines of production is effort almost wasted. Is the bare fact that these lands once bore fruit sufficient reason to desire their reoccupancy? If wealthy men from our cities seek these naturally beautiful sites for the summer home, by all means let us encourage their sale; but for purely agricultural purposes is it wise at present to advise their use?

In my native town one of those cast-aside stage coaches before referred to was brought out from its hiding place by one of these same city men. Paint, varnish, and slight remodelling changed this neglected vehicle into the pretentious tally-ho; with four-in-hand and bugle blast it gave its merry passengers a sightly seat from which to view the beauty and grandeur of Berkshire's hills and valleys. I should strongly advise making a similar tally-ho as often as a customer can be found; for ordinary travel, however, let the stage coach, like the abandoned farm, remain in idleness.

I am by no means proclaiming the decadence of Massachusetts farming, I am asserting that competition has driven the successful farmer from old methods to intelligent methods along a few well-chosen lines. The aggregate value of the State's agricultural products has constantly increased, while the number and variety of those products have greatly changed. Let us now turn to a consideration of some of those products, for if, notwithstanding loss in many lines, there has been an aggregate gain, it is well to examine the lines upon which such gain has been made. If our loss has been largely in those products which may be brought from a distance, then we may expect to find our gain in those articles which must be grown near to the consumer; in other words, in the products which are perishable. If this be true, does it imply occupation but for the few? Not at all; to supply the wants of two and one-half millions of people in these products alone will give abundant scope for our activities.

Let us first look at the milk industry, and see if our theory holds true. The sterilization of milk may be made practicable in the future; at the present it is fair to consider it as perishable. In 1865 the value of the beef product of Massachusetts was $8,188,564, in 1885 $718,932, — a loss in twenty years of $7,469,632. How can we expect to make up such an appalling deficit? Let us look at the milk account for relief. In 1865 the value of our milk product was $1,956,187, in 1885 $10,312,762,— a gain of $8,356,575; thus not only making up our loss on beef, but leaving nearly $1,000,000 to spare. Does this look like decadence in Massachusetts farming? Let us further examine the figures bearing upon this increasing article of food, for they are worthy of careful scrutiny. In 1845 we produced 2,850,412 gallons; in 1855, 3,300,916; in 1865, 10,079,180; in 1875, 35,698,159; in 1885, 72,528,628. In the year 1895, by the same ratio of increase, we will produce 150,000,000 gallons. Here then is an industry that Massachusetts farmers may hope to hold within their grasp; the laws for its production may therefore well be studied and restudied. The choice and breeding of our milch cows, the feeding, care and handling of these delicate machines, though old and oft-discussed subjects, demand increasing intelligence and stricter business methods upon the part of our dairymen. Civil laws have been enacted to protect the interest of both the producer and the consumer of milk; now let the natural laws that lie about its cheap production receive our closest attention.

Let us next consider the butter product. The figures of its production indicate growth, but by no means a healthy development. In 1845 we produced 7,668,556 pounds, in 1885 9,685,539,—a gain of 26 per cent. That which has been considered by many its greatest enemy has by legal enactment been locked behind the bars. Doubtless oleomargarine should be relegated to its own merits, if it has any. Let the energy and thought used to compass its restriction now be turned upon the best methods to produce gilt-edged butter at the least possible cost; for, while oleomargarine has occupied our thought, legitimate competitors have been securing our market. This sharpshooter has engaged our attention while the sappers and miners have been stealthily undermining our camp.

Ex-Governor Hoard, in his practical, pungent exhortations to Eastern farmers, is hailing the advent of twenty cents a pound for first-quality creamery butter; thus his wish is but an expression of his prophecy. Coming, as it does, from the editor of one of our ablest and most widely circulated dairy papers, it forcibly and irresistibly thrusts upon our notice the coil of competition that is being gradually girded about the butter industry of New England by the vast dairy possibilities of the West. Are we to be strangled? that is the vital question. We have already attended the obsequies of the cheese industry; is another funeral soon to be solemnized? In 1885 we made 972,211 pounds of cheese; in 1845, 7,262,637 pounds. Who at that time would have predicted a decline of 86 per cent in but forty years in this industry? The cheese vat was then to be found in every dairy house; now it is a thing of the past. This article of cheese is another striking example of the effect of competition upon a product that bears long transportation.

His Excellency Governor Russell, in his recent inaugural address, honors this Board by calling attention to its importance and usefulness; he does it yet higher honor, by advising that greater specific work and responsibilities be entrusted to its guidance and care. In view of the importance of our dairy interests, what better work can this Board undertake than to suggest the means by which scientific results, with the best practical methods upon all that pertains to the dairy, shall be taught to the masses? The itinerant dairy school is working the leaven of dairy skill and intelligence in many of our sister States; shall less be done for our own? We have, according to our last census, approximately 250,000 cows, heifers and bulls; should not direct and practical steps be taken to educate the *breeding-up* of these the dairyman's living machines? Who has listened to the lectures of Professor Roberts of Cornell upon the laws of breeding, but realizes what a field for effort is open upon this line? Could we do better than to employ such an expert to go among our farmers, and popularize and instill the laws that govern successful breeding?

Then, too, a knowledge of the science of feeding, thanks to Dr. Goessmann, to Professor Stewart, to Professor Henry and many other patient investigators, is indispensable. How to skillfully mix the materials at hand to make the balanced ration is no longer held as a theory, but is accepted as a truth by intelligent feeders. What proportion of our milk producers can mix the materials that should make the cow's daily ration, giving these factors each their due value? First, the commercial value of the mixture; second, its nutritive value for the product desired; third (but by no means least), its manurial value. To bring these laws simply and plainly to our farmers, so that they will act upon them, is a field for earnest effort. As bearing upon this feeding question, does it speak for our intelligence when statistics show that, of the six hundred thousand tons of hay produced in our State, but two and one-half per cent is clover? It is not idle talk when I advocate that it would pay large dividends to employ a preacher eloquent in speech, untiring in effort, to proclaim the gospel of clover.

I have elsewhere indicated the general lines of production upon which we may best meet competition; time forbids my enlarging upon them. Fresh vegetables must be grown near to the consumer. This industry shows a money return in 1885 of $5,227,194; figures are not at hand to study its comparative growth. It is significant to note that, on account of its importance, Boston and Worcester rank first in the State, not alone as commercial centres, but also as farming towns. Fruits and berries are in constantly increasing demand; strawberries and cranberries alone in 1885 gave a return of nearly $1,000,000. I predict that our next census will show rapid development in these two products. Fresh eggs and poultry should receive more than a passing remark, for they are lines for profitable production.

I have now endeavored to call attention to the fact, first, that competition demands of the Massachusetts farmer a wise choice in the lines of production sought; and, second, that intelligence along those lines of production is also demanded. I say intelligence. Our general government recognizes this want by her generous gifts to our experiment stations. Massachusetts, ever ready to contribute for the education of her children, has acknowledged the farmer's claim by her gifts to our Agricultural College. If the times are calling for the *educated* farmer, should not this Board, by its advice, more by its earnest pleading, demand that still larger sums shall be granted this college? Let the affection and interest of our farmers be more and more enlisted for this institution, feeling sure that here our sons may be trained to be kings and priests in this noble calling. Who that has visited this seat of learning, has looked upon the beauty of its surroundings, has examined the object lessons here given for the best agricultural methods; who has studied its curriculum, with appliances for thorough instruction; who has looked into the faces of these young men, soon to be the standard bearers along the lines of intelligent farming,—but is led to exclaim, "Beautiful for situation, let it become the joy and pride of our glorious Commonwealth." Let us remember that here may be gained the weapons which shall enable the farmer to give real honor and dignity to his calling; the weapons that shall best enable him to meet this great law of competition, and so learn that competition is not to be looked upon necessarily as an enemy, but rather as the tonic which has stimulated effort more and more upon those lines which we may hope to hold in this race and struggle for supremacy. Competition, with its eager and relentless tread, untiring in its search for methods still better, for products still cheaper, must ever stand in contrast with monopoly, which tends to stifle, and to compel the acceptance of that which may be neither cheapest nor best. I say, then, that competition puts a premium upon intelligence, upon skill, upon business methods, upon indomitable pluck, upon untiring industry, upon a wise choice of the kind of product sought. It does away, if one covets success, with the attempt to raise a little of everything, and compels the farmer to fall into line with workers in all other industries, and become himself a specialist. It insists that, to gain the highest success, individuality must be stamped upon the product sold; whatever the article may be, let our own individual skill go with the product, to give it increased selling value. The farmer who puts *skill* into the manufacture of his butter, and makes sure that the consumer shall know just *whose* skill is represented in the nutty, sweet-scented product, may have a satisfactory margin of profit, and well illustrates this principle; while the man who packs his butter, though equally good, into an unmarked firkin, and sends it unnamed upon a general market, invites a competition so fierce that no profit rewards his labor. Deerfoot Farm uses the same skill in advertising its excellent products, by having every package marked "Deerfoot," that the manufacturer Byron Weston displays in insisting that every ream of his famous ledger paper shall carry the name "Weston."

I have now pointed out some factors that are necessary to insure success in New England farming. Loudly has the bugle sounded for the farmer to organize; while hearing this call, let him still remember that, for him, the very best organization is the training and arousing of his own powers. To-day Massachusetts farming invites the intelligent, the industrious, the enthusiastic to join its lists, promising success as great as can be attained anywhere in our broad land.

THE EMPLOYMENT OF FARM LABOR.

BY W. A. KILBOURN OF SOUTH LANCASTER.

The old-fashioned term, "help," has been dropped, and the word "labor" used, with a peculiar significance. Fifty years ago a farmer found help in the sons of his neighbors of his own town, or the hardy young men from Vermont and New Hampshire, who were help indeed. To-day, with few exceptions, the men employed are of a different race, with very different character, and, we do them no injustice in saying, one which does not compare favorably with the Yankee grit and efficiency. Yet the labor we have to-day, such as it is, is the most important matter for the farmer to consider. It is often the largest item of expense, and very often the least satisfactory one. Yet upon the farmer himself depends very much the efficiency and character of the help in his employment. In other words, his help is what he makes it. I do not mean that an inefficient, ignorant man can be made industrious, efficient and intelligent, though much may be done in this direction by a careful employer; but I mean that an inefficient, unsatisfactory man may be replaced when his time expires by one more competent, and he again by one still better, if the farmer is watchful, and willing to pay something for faithful service. It is true that, under the present conditions of labor, the farmer cannot pay much difference in wages to the men he employs; but he can make it an object for the best men to stay with him through the year, and through the next year too, by making his employment constant, and by letting the man understand that his service is satisfactory. This is a very strong point; for many men can do well if they feel that they are giving good satisfaction, and will make a strong effort to do what is wanted, with a little encouragement, who will be very inefficient if found fault with.

Men who are worth employing at all know that it is for their interest to do what the employers want, and will try to do it, however unsuccessfully. It is a proof of the farmer's good judgment if he can select those who give reasonable prospect of success, and who will become efficient with encouragement and instruction, and can drop those who will surely be a source of trouble, from their bad habits and irregularity. It is better still if the farmer can make this selection beforehand. If an undesirable applicant comes, the farmer may decline to employ at that time; or, if in great need of help, he may put the man to work for a short time, with the understanding that he will be employed only so long as he shall do well. In this way very ordinary help will do reasonably well for a week or a month, and at the end of the time can be paid off, and, as opportunity offers, the place can be better filled, temporarily, till a satisfactory man is found. Then it is equal proof of the farmer's good judgment to keep such a man.

It is a mistake to find fault with men. It is a mistake to discharge a man before his time is completed, for any ill-considered cause. It is an equal mistake to keep a man long employed, if he does not comply with your wishes and use his best efforts to meet your requirements. One such man, kept after his character is known, is a source of trouble with all the other men who may be employed. They are quick to notice, perhaps quicker than the employer himself, unfaithfulness and wrong habits; and, if these go long unnoticed, they will soon take like liberties themselves, and will drop their standard to that of the poorest man allowed to retain a permanent place. On the other hand, if they find that this poorest man is pretty promptly dropped, they will take good care to do better than he did, and the standard can be made higher every time.

It is poor policy to discuss with one's neighbors the character of the men employed, either their good qualities or their bad ones. If the good qualities are made public, some one may hire the men away from you; if the bad qualities are mentioned, you condemn yourself for keeping such men, and your words may come to the men themselves, and be the cause of no little ill feeling. In the case of men no longer employed, you do them an injustice, besides hurting yourself indirectly among other men, who might desire to work for you, but who will hesitate if you have the repute of giving a man a bad name.

If the question of recommendation comes, give such an one as you honestly can,— such an one as you would wish to receive from a former employer, if the man were coming to you instead of leaving your employment.

Treat a man well while he is with you and he will feel that it is his interest to stay with you, and as a rule he will try to meet your wishes. If a better place is offered to him than you can afford to give, help him to take it with good-will, and pay him for the time he has served you. If these simple rules are followed, three men will apply for the vacancy for every man that leaves you, and it is your own fault if you cannot make a fair selection.

Remember the exacting, never-ending duties of the farm, three hundred and sixty-five days in the year, and make reasonable allowance before finding fault; and be sure, for every fault-finding, cross word spoken, you lose more than you gain.

These rules apply equally well to the help kept in the house; and, if faithfully carried out, good servants will soon apply when a vacancy occurs, and will stay with you till some good cause takes them away. Such has been the experience of the writer for nearly twenty years. During the whole time but two men have met with prompt discharge, though a good many have found their term of service short, and no opening for a return.

Second, the kind of men to be employed. For a great number of farms, where but one or two men are employed, many different kinds of work are to be done, from holding the plough to picking the apples; and the man is often received as a member of the family. On such farms too much care cannot be used in making a selection, or too much consideration used in keeping a good man when found. The character, the habits and the way of doing work of such a man have much influence on the farmer's growing boys, and they are only too likely to fall into his ways. Much better is it for the farmer to pay a few dollars more in the month or year for a first-class man, than to employ at a lower price a man whose evil influence or bad habits may leave their marks where no money can efface them.

For such places a few men can still be found worthy of the old name of help, well worth searching for, and still better worth keeping. Such places require men well trained, industrious, and of good common sense; but they are often filled by men who fall far below this standard, or whose bad habits make them a nuisance, simply because the farmer tries to save in the wrong place, or is too careless to look after his own interest. For such a farmer there is no cure but the costly lesson of experience.

The larger farms, where five or six men are employed, require men of somewhat different qualities. Usually two or three must be good milkers, and accustomed to cattle; two must be teamsters; and the other two must be good all-around men, who can milk a cow or drive a team if needed in the absence or sickness of the others. For these places, if men can be found who can be trusted to do a day's work in a day, and who will do it for days in succession, the better farmer will hire them in place of men he must watch every day and all day; and he will find the small difference in wages well spent, just as the better farmer will find the small difference in cost of full feed and the feed of support for his stock the money which gives him the best return. So the increased cost of trusty, faithful men is the best use to which money can be put.

Upon such farms, employing five or six men most of the year, some extra men are usually employed six or eight months. If among these one is found more faithful than the others, let him be kept for the year, and the chance of this will stimulate the others to do well. In other words, let faithful service be encouraged, and farmers will have less reason to complain.

DIRECTORY

OF THE

Agricultural and Similar Organizations in the State.

FEBRUARY, 1892.

STATE BOARD OF AGRICULTURE.

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His Excellency WM. E. RUSSELL.
His Honor WM. H. HAILE.
Hon. WM. M. OLIN, *Secretary of the Commonwealth.*
H. H. GOODELL, M.A., LL.D., *President Massachusetts Agricultural College.*

Members appointed by the Governor and Council.

	Term Expires.
JAMES S. GRINNELL of Greenfield,	1893
ELBRIDGE CUSHMAN of Lakeville,	1894
D. A. HORTON of Northampton,	1895

Members chosen by the Incorporated Societies.

Amesbury and Salisbury (Agr'l and Hort'l),	F. W. SARGENT of Amesbury,	1894
Attleborough (Agr'l Assoc'n),	ISAAC ALGER of Attleborough,	1894
Barnstable County,	JOHN BURSLEY of West Barnstable,	1895
Bay State,	F. H. APPLETON of Peabody (P.O. Lynnfield),	1893
Berkshire,	CHAS. A. MILLS of Southborough,	1894
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Bristol County,	N. W. SHAW of North Raynham,	1893
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Eastern Hampden,	WM. HOLBROOK, M.D., of Palmer,	1894
Essex,	BENJAMIN P. WARE of Marblehead (P. O. Clifton),	1893
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Hampden,	C. F. FOWLER of Westfield,	1894
Hampshire,	L. W. WEST of Hadley,	1895
Hampshire, Franklin and Hampden,	E. C. CLAPP of Northampton,	1894
Highland,	HIRAM TAYLOR of Middlefield,	1893
Hillside,	WM. BANCROFT of Chesterfield,	1893
Hingham (Agr'l and Hort'l),	EDMUND HERSEY of Hingham,	1894
Hoosac Valley,	A. J. BUCKLIN of Adams,	1894
Housatonic,	J. H. ROWLEY of Egremont Plain,	1894
Marshfield (Agr'l and Hort'l),	L. S. RICHARDS of Marshfield (P. O. Marshfield Hills),	1894
Martha's Vineyard,	N. S. SHALER of Cambridge,	1895
Massachusetts,	HENRY S. RUSSELL of Milton,	1894
Massachusetts Horticultural,	E. W. WOOD of West Newton,	1894
Middlesex,	W. W. RAWSON of Arlington,	1894
Middlesex North,	A. C. VARNUM of Lowell,	1895
Middlesex South,	S. B. BIRD of Framingham,	1893
Nantucket,	GEO. H. GARDNER of Nantucket,	1894
Oxford,	JOHN E. KIMBALL of Oxford,	1895
Plymouth County,	AUGUSTUS PRATT of North Middleborough,	1893
Spencer (Far's and Mech's Assoc'n),	EDWARD WARREN of Leicester,	1895
Union (Agr'l and Hort'l),	G. C. ROWLEY of Blandford,	1895
Weymouth (Agr'l and Ind'l),	QUINCY L. REED of South Weymouth,	1894
Worcester,	C. L. HARTSHORN of Worcester,	1893
Worcester East,	W. A. KILBOURN of South Lancaster,	1894
Worcester North,	GEORGE CRUICKSHANKS of Fitchburg,	1893
Worcester North-west (Agr'l and Mechn'l),	WM. H. BOWKER of Boston,	1895
Worcester South,	G. L. CLEMENCE of Southbridge (P. O. Globe Village),	1895
Worcester County West,	P. M. HARWOOD of Barre,	1893

Secretary of the Board, WM. R. SESSIONS of Hampden.
Chemist to the Board, C. A. GOESSMANN, Ph.D., LL.D., of Amherst.
Entomologist to the Board, C. H. FERNALD, Ph.D., of Amherst.
Office of the Secretary, Commonwealth Building, Boston.

MASSACHUSETTS AGRICULTURAL COLLEGE.

Location, Amherst, Hampshire County.

BOARD OF TRUSTEES.

Board of Trustees.	Term Expires.
THOMAS P. ROOT of Barre,	1893
J. HOWE DEMOND of Northampton,	1893
FRANCIS H. APPLETON of Peabody,	1894
WILLIAM WHEELER of Concord,	1894
ELIJAH W. WOOD of West Newton,	1895
CHAS. A. GLEASON of New Braintree,	1895
DANIEL NEEDHAM of Groton,	1896
JAMES DRAPER of Worcester,	1896
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897
JAMES S. GRINNELL of Greenfield,	1898
JOSEPH A. HARWOOD of Littleton,	1898
WILLIAM H. BOWKER of Boston,	1899
J. D. W. FRENCH of North Andover,	1899

MEMBERS EX OFFICIO.

His Excellency Governor WM. E. RUSSELL,
President of the Corporation.

HENRY H. GOODELL, M.A., LL.D.,	*President of the College*
JOHN W. DICKINSON,	*Secretary of the Board of Education.*
WILLIAM R. SESSIONS,	*Secretary of the Board of Agriculture.*

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JAMES S. GRINNELL of Greenfield,	*Vice-President of the Corporation.*
WILLIAM R. SESSIONS of Hampden,	*Secretary.*
PROF. GEO. F. MILLS of Amherst,	*Acting Treasurer.*
CHARLES A. GLEASON of New Braintree,	*Auditor.*

BOARD OF OVERSEERS.

The State Board of Agriculture.

EXAMINING COMMITTEE OF THE BOARD OF AGRICULTURE.

Messrs. MILLS, CRUICKSHANKS, HARWOOD, HOLBROOK, CLEMENCE and VARNUM.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

HENRY H. GOODELL, M.A., LL.D.,	*Director.*
WILLIAM P. BROOKS, B.Sc.,	*Agriculturist.*
SAMUEL T. MAYNARD, B.Sc.,	*Horticulturist.*
CHARLES H. FERNALD, Ph D.,	*Entomologist.*
CLARENCE D. WARNER, B.Sc.,	*Meteorologist.*

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION.

Location, Amherst, Hampshire County.

BOARD OF CONTROL.

His Excellency WM. E. RUSSELL, Governor of the Commonwealth, *President ex officio.*

	Term Expires.
WM. H. BOWKER of Boston,	1895
CALVIN L. HARTSHORN of Worcester,	1894
Elected by the State Board of Agriculture.	
THOMAS P. ROOT of Barre,	1894
J. HOWE DEMOND of Northampton,	1893
Elected by the Board of Trustees of the Massachusetts Agricultural College.	
FRANCIS H. APPLETON of Peabody,	1894
Elected by the Massachusetts Society for Promoting Agriculture.	
WM. H. PORTER of Agawam,	1895
Elected by the Massachusetts State Grange.	
WILLIAM C. STRONG of Newton (P. O. Waban),	1894
Elected by the Massachusetts Horticultural Society.	

HENRY H. GOODELL, M.A., LL.D., of Amherst, *President of the Massachusetts Agricultural College.*

CHARLES A. GOESSMANN, Ph.D., LL.D., of Amherst, *Director of the Station.*

WILLIAM R. SESSIONS of Hampden, *Secretary of the State Board of Agriculture.*

OFFICERS ELECTED BY THE BOARD OF CONTROL.

HENRY H. GOODELL, M.A., LL.D., of Amherst,	*Vice-President.*
WILLIAM R. SESSIONS of Hampden,	*Secretary and Auditor.*
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JAMES E. HUMPHREY, S.B., of Amherst,	*Vegetable Physiologist.*

BOARD OF CATTLE COMMISSIONERS.

	Term Expires.
LEVI STOCKBRIDGE of Amherst, *Chairman*,	1891
ALONZO W. CHEEVER of Dedham, *Secretary*,	1893
OBADIAH B. HADWEN of Worcester,	1892

AGRICULTURAL SOCIETIES INCORPORATED BY SPECIAL ACT OF LEGISLATURE, AND REPRESENTED ON THE BOARD OF AGRICULTURE.

NAME.	PRESIDENT.	SECRETARY.	TREASURER.
Amesbury and Salisbury,* .	F. W. Sargent, Amesbury.	A. H. Fielden, Amesbury.	W. H. Dewhurst, Amesbury.
Attleborough (Agric'l Asso.),	Joseph G. Barden, North Attleborough.	L. F. Mendell, North Attleborough.	W. H. Wade, Plainville.
Barnstable County, . .	John Simpkins, Yarmouth.	Fred C. Swift, Yarmouth.	Albert F. Edson, Barnstable.
Bay State,†	J. D. W. French, Boston.	C. M. Weld, Boston.	I. B. Sayles, Milford.
Berkshire, ...	Walter Cutting, Pittsfield.	R. H. Cooke, Pittsfield.	J. P. Merrill, Pittsfield.
Blackstone Valley, . .	Arthur R. Taft, Uxbridge.	William L. Johnson, Uxbridge.	James M. Farnum, Uxbridge.
Bristol County, . . .	Morgan Rotch, New Bedford.	A. B. Hodges, Taunton.	J. R. Tallman, Taunton.
Deerfield Valley, . . .	H. A. Howard, Colrain.	S. W. Hawkes, Charlemont.	H. N. Warner, Charlemont.
Eastern Hampden, . .	W. M. Tucker, Monson.	O. P. Allen, Palmer.	O. P. Allen, Palmer.
Essex, ...	Francis H. Appleton, Lynnfield.	J. M. Danforth, Lynnfield Centre.	G. L. Streeter, Salem.
Franklin County, . .	F. L. Whitmore, Sunderland.	F. L. Greene, Greenfield.	F. L. Greene, Greenfield.
Hampden, ...	F. E. Clark, Wilbraham.	Ethan Brooks, West Springfield.	E. S. Batchelder, Springfield.
Hampshire, ...	William P. Brooks, Amherst.	H. C. Nash, Jr. Amherst.	H. C. Nash, Jr., Amherst.
Hampshire, Franklin and Hampden, ...	C. B. Lyman, Southampton.	W. H. Riley, Northampton.	D. J. Wright, Northampton.
Highland, ...	Henry A. Barton, Jr., Dalton.	J. McElwain, Middlefield.	M. J. Smith, Middlefield.
Hillside, ...	Alvan Barrus, Goshen.	William G. Atkins, West Cummington.	R. R. Packard, Cummington.
Hingham,*	E. L. Ripley, Hingham.	William H. Thomas, Hingham.	Reuben Sprague, Hingham.
Hoosac Valley, . . .	Foster E. Swift, North Adams.	George F. Miller, North Adams.	S. B. Dibbie, North Adams.
Housatonic, ...	W. H. Ticknor, Alford.	H. T. Robbins, Great Barrington.	W. B. Sanford, Great Barrington.
Marshfield,*	G. W. Emery, Marshfield.	Francis Collamore, Pembroke.	Francis Collamore, Pembroke.
Martha's Vineyard, . .	H. G. Norton, Vineyard Haven.	B. T. Hillman, Chilmark.	D. W. Mayhew, West Tisbury.
Massachusetts, . . .	Thomas Motley, Jamaica Plain.	Francis H. Appleton, Lynnfield.	J. C. Rogers, Boston.
Middlesex, ...	W. W. Rawson, Arlington.	William H. Hunt, Concord.	D. G. Lang, Concord.
Middlesex North, . .	A. C. Varnum, Lowell.	E. T. Rowell, Lowell.	S. Drewett, Lowell.
Middlesex South, . .	Isaac Damon, Cochituate.	Edgar Potter, South Framingham.	C. J. Frost, Framingham.
Nantucket, ...	John Harps, Nantucket.	J. F. Murphey, Nantucket.	Asa C. Jones, Nantucket.
Oxford, ...	A. L. Joslin, Oxford.	W. H. H. Thurston, Oxford.	W. H. H. Thurston, Oxford.
Plymouth County, . .	J. C. Swan, West Bridgewater.	George M. Hooper, Bridgewater.	John M. Stetson, Bridgewater.
Spencer (Farmers and Mechanics Association), .	C. N. Prouty, Spencer.	F. B. Watson, Spencer.	A. W. Curtis, Spencer.
Union,*			

Weymouth (Ag'l and Ind.),	B. F. Poole, Rockland.	H. Wilbur Dyer, South Weymouth.	Gordon Willis, South Weymouth.
Worcester, ...	J. L. Ellsworth, Worcester.	F. H. Chamberlain, Worcester.	F. H. Chamberlain, Worcester.
Worcester East, . . .	John E. Thayer, Lancaster.	W. A. Kilbourn, South Lancaster.	Lucius Field, Clinton.
Worcester North, . . .	George N. Proctor, Fitchburg.	S. W. Huntley, Fitchburg.	A. F. Whitney, Fitchburg.
Worcester North-west (Ag'l and Mechanical), . .	A. D. Raymond, Royalston.	James F. Whitcomb, Athol Centre.	T. H. Goodspeed, Athol Centre.
Worcester South, . . .	George W. Wells, Southbridge.	C. V. Corey, Sturbridge.	C. V. Corey, Sturbridge.
Worcester County West, .	Charles G. Allen, Barre.	Matthew Walker, Barre.	Charles H. Follansby, Barre.

* And horticultural. † Incorporated under general laws.

HORTICULTURAL SOCIETIES.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Hampden County, ...	Springfield, ...	J. E. Taylor, Springfield.	B. L. Bragg, Springfield.
Houghton, ...	Lynn, ...	J. W. Goodell, M. D., Lynn.	Frank W. Mace, Lynn.
Hyde Park, ...	Hyde Park, . . .	W. C. Eustis, Hyde Park.	George E. Haven, Hyde Park.
Massachusetts,*	Boston, ...	William H. Spooner, Jamaica Plain.	Robert Manning, Boston.
Newton, ...	Newton, ...	D. D. Slade, Chestnut Hill.	L. H. Farlow, Newton.
Springfield Amateur, ...	Springfield, ...	Joseph Aumer, Springfield.	George H. Lapham, Springfield.
Wakefield,†	Wakefield, ...	Edwin C. Miller, Wakefield.	Mrs. J. F. Woodward, Wakefield.
Worcester County, ...	Worcester, ...	H. L. Parker, Worcester.	E. W. Lincoln, Worcester.

Farmers' and Mechanics' Associations.

Princeton, ...	Princeton, ...	J. C. F. Mirick, Princeton.	J. E. Merriam, Princeton.
Oakham, ...	Oakham, ...	H. P. Austin, Oakham.	William S. Crawford, Oakham.
Needham, ...	Needham, ...	Joseph Smith, Needham.	A. K. Tisdale, Dover.
Leominster, ...	Leominster, . . .	A. L. Whitney, Leominster.	C. H. Rice, Leominster.
Bolton, ...	Bolton, ...	H. F. Haynes, Bolton.	W. M. Brigham, Bolton.
Middlesex and Worcester, . . .	Hudson, ...	Francis Howe, Hudson.	Josiah S. Welsh, Hudson.

* Incorporated and represented on the Board of Agriculture. † And agricultural.

Farmers' and Mechanics' Clubs.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Holden,	Holden,	F. E. Parker, Holden.	Franklin Moore, Holden.
West Acton,	West Acton,	Isaac Reed, West Acton.	C. B. Stone, West Acton.
Ashby,	Ashby,	H. S. Brooks, Ashby.	E. A. Hubbard, Ashby.
Berlin,	Berlin,	P. B. Southwick, Berlin.	F. H. Crossman, Berlin.
Groton,	Groton,	Daniel Needham, Groton.	Charles Woolley, Groton.
Wilmington,	Wilmington,	John T. Wild, Wilmington.	E. M. Nichols, Wilmington.
Belchertown,	Belchertown,	J. R. Gould, Belchertown.	A. B Howard, Belchertown.
Shrewsbury,	Shrewsbury,	B. E. Tucker, Shrewsbury.	F. J. Stone, Shrewsbury.
Shirley,	Shirley,	E. G. Adams, Shirley.	G. C. Boutwell, Shirley.
Pepperell,	Pepperell,	. . . .	S. R. Merrill, Pepperell.

Farmers' Clubs.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Ashfield,	Ashfield,	C. O. Temple, Ashfield.	A. G. Howes, Ashfield.
Boxborough,	Boxborough,	C. H. Burroughs, West Acton.	A. W. Wetherbee, West Acton.
Buckland,	Buckland,	R. N. Allen, East Charlemont.	Mrs. F. Forbes, Buckland.
Burlington,	Burlington,	T. I. Reed, Burlington.	Harry H Nichols, Burlington.
Chamberlain District,	Worcester,	B W. Potter, Worcester.	S. A. Burgess, Worcester.
East Charlemont,	East Charlemont,	Charles H. Leavitt, East Charlemont.	Lyman Whiting, East Charlemont.
Easthampton,	Easthampton,	L. E. Parsons, Easthampton.	George H. Parsons, Mount Tom.
Franklin,	Franklin,	L. W. Daniels, Franklin.	C. M. Allen, Franklin.
Halifax,	Halifax,	Otis Pratt, Halifax.	Mrs. J. S. Pope, Halifax.
Huntington,	Huntington,	C. H. Strong, Norwich.	H. W. Stickney, Norwich.
Lancaster,	Lancaster,	George W. Morse, South Lancaster.	F. A. Hanaford, South Lancaster.
Lunenburg,	Lunenburg,	C. E. Cox, Lunenburg.	James Hildreth, 2d, Lunenburg.
Marblehead and Swampscott,	Beach Bluff,	William Miller, Swampscott.	
New Braintree,	New Braintree,	J. E. Barr, New Braintree.	E. W Barr, New Braintree.
New Salem,	New Salem,	W. J. Whitaker, New Salem.	Daniel Ballard, Millington.
North Raynham,	North Raynham,	E. B. Hall, North Raynham.	N. W. Shaw, North Raynham.
North Westport,	North Westport,	E. L. Gifford, North Westport.	A. S. Sherman, North Westport.

Practical,	Egremont,	H. T. Cande, Sheffield.	Mrs. T. S. Baldwin, N. Egremont.
Rehoboth,	Rehoboth,	Henry T. Horton, Rehoboth.	Ellery L. Goff, Rehoboth.
Rowley,	Rowley,	J. D. Dodge, Rowley.	T. P. Hale, Rowley.
Royalston,	Royalston,	A. D Raymond, Royalston.	G. E. Pierce, Royalston.
Rutland,	Rutland.	L. Q. Spaulding, Rutland.	A. L. Miles, Rutland.
Southborough,	Southborough,	E. B. Simpson, Southborough.	D. C. McMasters, Southborough.
South Bristol,	New Bedford.	Franklyn Howland, Acushnet.	Geo. A. Potter, New Bedford.
South Deerfield,	South Deerfield,	E. W. Jackson, South Deerfield.	W. W. Sanderson, South Deerfield
Sterling,	Sterling,	John P. Brittle, Clinton.	H. P. Kendall, Sterling.
Tatnuck,	Worcester,	F. J. Kinney, Worcester.	H. B. Watts, Worcester.
Upton,	Upton,	G. S. Ball, Upton.	Benjamin C. Wood, Upton.
Waltham,	Waltham,	M. R. Leonard, Waltham.	A. Starbuck, Waltham.
West Bridgewater,	West Bridgewater,	F. E. Howard, West Bridgewater.	Mrs. H. J. LeLacheur, W. Bridgewater.
West Brookfield,	West Brookfield,	W. E. Patrick, Warren.	L. H. Chamberlain, West Brookfield.
West Newbury,	West Newbury,	L. W. Bradley, West Newbury.	I. N. Lane, West Newbury.
West Peabody,	West Peabody,	D. A. Small, West Peabody.	Mrs. E. A. Needham, West Peabody.
Wilbraham,	Wilbraham,	James Richards, Wilbraham.	H. M. Bliss, Wilbraham.

MISCELLANEOUS.

Agricultural Library Association,	Swansea,	N. B. Gardner, Swansea.	A. E. Arnold, Swansea Centre.
Boston Market Gardeners' Association,	Boston and vicinity,	W. W. Rawson, Arlington.	C. A. Learned, Arlington.
Bristol Co. Fruit Growers' Association,	Dighton,	William P. Hood, Somerset.	W. P. Eddy, Dighton.
Brockton Agricultural Society,*	Brockton,	H. W. Robinson, Brockton.	Ira Copeland, Brockton.
Cranberry Growers' Association,	Cape Cod District,	J. J. Russell, Plymouth.	I. T. Jones, Sandwich.
Farmers' and Gardeners' Club,	Hanson,	James McRoberts, Hanson.	F. S. Thomas, M. D., Hanson.
Franklin Harvest Club,	Connecticut Valley,	J. C. Newhall, Conway.	C. B. Lyman, Southampton.
Hampden Harvest Club,	Connecticut Valley,	The members alternately.	J. N. Bagg, West Springfield.
Westborough Agricultural Society,*	Westborough,	N. P. Brown, Westborough.	B. W. Hero, Westborough.
Youngs Men's Harvest Club,	Ludlow,	C. B. Bennett, Ludlow.	E. N. Fisher, Ludlow.
Young People's Agricultural Club,	Wilbraham,	Lee W. Rice, Wilbraham.	Walter M. Bliss, Wilbraham

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* Incorporated under general laws,

MASSACHUSETTS PATRONS OF HUSBANDRY.

Officers of the State Grange, 1892.

Master,	E. D. Howe of Marlborough.
Overseer,	A. C. Stoddard of North Brookfield.
Lecturer,	J. W. Stockwell of Sutton.
Steward,	E. A. Emerson of Haverhill.
Assistant Steward,	Geo. L. Davis of Shrewsbury.
Chaplain,	Rev. C. S. Walker of Amherst.
Treasurer,	F. A. Harrington of Worcester.
Secretary,	W. C. Jewett of Worcester.
Gate Keeper,	C. H. Deming of Lanesborough.
Ceres,	Mrs. C. E. Robinson of Hinsdale.
Pomona,	Mrs. E. Cushman of Lakeville.
Flora,	Mrs. Minnie M. Chase of Medfield.
Lady Assistant Steward,	Mrs. F. L. Chamberlain of Greendale.

Executive Committee.

S. E. Stowe of Grafton,	One year.
H. A. Barton, Jr., of Dalton,	Two years.
C. A. Dennen of Pepperell,	Three years.

Deputies.

A. A. Metcalf,	Holden.
A. C. Stoddard,	North Brookfield.
D. A. Horton,	Northampton.
Wesley B. Barton,	Dalton.
George A. Hastings,	Boylston Centre.
Warren C. Jewett,	Worcester.
James Hildreth, 2d,	Lunenburg.
John W. Gifford,	South Westport.
N. B. Douglas,	Sherborn.
Elbridge Cushman,	Lakeville.
E. A. Emerson,	Haverhill.

Special Deputy.

George R. Chase,	Medfield.

Massachusetts Patrons of Husbandry — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Pomona Granges.			
Middlesex and Norfolk, No. 1,	George R. Chase, Medfield.	Rev. Daniel Round, Norfolk.	Belle R. Hayward, Fayville.
Essex County, No. 2,	Lawrence H. Bailey, West Newbury.	Stephen K. Fowler, Boxford.	J. Warren Mooar, Andover.
Middlesex and Worcester, No 3,	James Hildreth, 2d, Lunenburg.	J. L. Harrington, Lunenburg.	Annie E. Robbins, Groton.
Franklin and Worcester, No. 4,	Horace Drury, 2d, Athol Centre.	M. R. Hartshorn, Tully.	Flora J. Butterworth, Athol.
District Granges.			
Berkshire County,	Wesley B. Barton, Dalton.	F. H. Palmer, Stockbridge.	John S. Cole, Hinsdale.
Worcester West District,	C. E. Bennett, Hubbardston.	L. Randall, Petersham.	Mrs. Mattie R. Knapp, Petersham.
Worcester Central County,	C. M. Wood, Upton.	D. M. Howe, Oxford.	Mrs. Annie S. Rice, Shrewsbury.
Borough District,	Henry Gilmore, Westborough.	E. D. Howe, Marlborough.	Mrs. Addison Keyes, Berlin.
Connecticut Valley District,	W. H. Bridgman, Belchertown.	Howard C. West, Belchertown.	Miss Sarah E. Mason, Northampton.
Worcester Southwest District,	W. H. Prince, Webster.	N. D. Ladd, Sturbridge.	A. M. Dodge, Charlton.
Lancaster District,	Geo. A. Hastings, Boylston Centre.	Charles Bray, Boylston Centre.	Mrs. E. Cunningham, Lancaster.
Springfield District,	W. F. Lathrop, East Longmeadow.	George Eastman, Granby.	Mrs. W. S. Phelps, Wilbraham.
Old Colony District,	J. A. Shores, West Bridgewater.	Elbridge Cushman, Lakeville.	Mrs. R. G. Buffinton, Fall River.
Mendon District,	William O. Burdon, Millville.	Dr. Nathan Sanborn, Bellingham.	Miss Mabel Spofford, Mendon.
Subordinate Granges.			
Groton, No 7,	George L. Smith, East Pepperell.	Daniel Needham, Groton.	Mrs. Ellen M. Needham, Groton.
Barre, No. 9,	J. L. Smith, Barre.	Mrs. S. C. Dresser, Barre.	Mrs. H. N. Patterson, Barre.
Amherst, No. 16,	C. E. Wakefield, Amherst.	Mrs. C. F. Morehouse, Amherst.	Emily R. Cook, Amherst.
Hinsdale, No. 19,	C. E. Robinson, Hinsdale.	Mrs. Emma F. Watkins, Hinsdale.	John S. Cole, Hinsdale.
Lanesborough, No. 21,	F. D. Deming, Lanesborough.	P. P. Gardner, Lanesborough.	Charles H. Deming, Lanesborough.
Worcester, No. 22,	Charles Greenwood, Worcester.	G. A. Cheney, Worcester.	Miss Ellen M. Flagg, Worcester.
Dalton, No. 23,	J. H. Smith, Dalton.	Mrs. Lucy A. Aldrich, Dalton.	M. Agnes Young, Dalton.
"Resolute" of Hatfield, No. 25,	Thaddeus Graves, Hatfield.	S. L. Cutler, Hatfield.	A. H. Graves, Hatfield.
Richmond, No. 32,	M. W. Coleman, West Pittsfield.	Mrs. M. W. Coleman, West Pittsfield.	Elizabeth P. Nichols, Richmond.
Sterling, No. 53,	L. W. Rugg, Sterling.	Mrs. J. S. Burpee, Sterling.	M. L. Coolidge, West Sterling.
Auburn, No. 60,	L. N. Stone, Auburn.	Ella F. May, Auburn.	H. J. Prouty, Auburn.
"Union" of Belchertown, No. 64,	W. H. Bridgman, Belchertown.	Mrs. H. F. Curtis, Belchertown.	H. C. West, Belchertown.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Hardwick, No. 67, . . .	J. H. Hillman, Hardwick.	Mrs. W. A. Newcomb, Hardwick.	Susie B. Manly, Hardwick.
Phillipston, No. 70, . . .	C. A. Moore, Phillipston.	J. W. Moore, Templeton.	Miss M. B. Hager, Templeton.
"Prescott" of Pepperell, No. 73,	W. G. Symes, Pepperell.	A. N. Blood, Pepperell.	Carrie L. Tarbell. Pepperell.
Holden, No. 78, ...	John W. Lowell, Holden.	William Hunter, Holden.	Mrs. S. N. Hubbard, Holden.
Spencer, No. 79, . . .	Edward Warren, Spencer.	O. H. Wilson, Spencer.	J. H. Blanchard, Spencer.
"Manhan" of Southampton, No. 82, ...	George K. Edwards, Southampton.	W. H. Adams, Southampton.	Miss Florence Hannum, Southampton.
North Orange, No. 86, . .	M. L. Gerhard, Tully.	M. D. Herrick, North Orange.	Ellen S. Prentice, Tully.
Lee, No. 88, ...	C. H. Shaylor, Lee.	H. L. Smith, Lee.	C. G. Hinckley, Lee.
Charlton, No. 92, . . .	A. M. Dodge, Charlton.	H. M. Dodge, Charlton.	Fannie E. Burlingame, Charlton.
Grafton, No. 93, . . .	S. H. Knowlton, Grafton.	Mrs. E. M. W. Fisk, Grafton.	Miss Emma J. Knight, North Grafton.
Petersham, No. 95, . . .	D. F. Bigelow, Petersham.	Mrs. M. A. Webb, Petersham.	Mrs. R. J. Stone, Petersham.
Shrewsbury, No. 101, . .	Hiram W. Loring, Shrewsbury.	Miss Lottie M. Howe, Shrewsbury.	Mrs. George H. Perry, Shrewsbury.
Stow, No. 103, ...	F. H. Stevens, West Acton.	Mrs. S. A. Peck, Stow.	Mrs. U. M. Lewis, Stow.
"Garfield" of North Dana, No. 101, ...	J. E. Doubleday, North Dana.	M. T. Knapp, North Dana.	Hattie Doubleday, North Dana.
Marlborough, No. 105, . .	C. S. Howe, Marlborough.	Angie Dudley, Marlborough.	Abbie A. Brigham, Marlborough.
West Boylston, No. 106, . .	Frank Prescott, West Boylston.	Rosa Boynton, West Boylston.	Fannie Brown, West Boylston.
Millbury, No. 107, . . .	H. W. Carter, Millbury.	Mrs. J. C. Hayward, Millbury.	I. E. Howe, Millbury.
Hudson, No. 108, . . .	F. P. Glazier, Hudson.	Mrs. A. H. Stowe, Hudson.	Miss Mary E. Hall, Hudson.
Sutton, No. 109, . . .	C. C. Hall, Millbury.	J. F. Humes, West Sutton.	Miss Sarah M. Mills, Sutton.
Sherborn, No. 110, . . .	F. T. Daniels, Sherborn.	Mrs. G. L. Whitney, South Framingham.	Miss M. I. Hayward, Sherborn.
Boylston, No. 111, . . .	C. H. Hastings, Clinton.	N. L. Kendall, Boylston.	Cora I Hastings, Clinton.
"East Medway" of Millis, No. 112, ...	Louis LaCroix, Millis.	Monroe Morse, Medway.	Geneive F. Howe, Millis.
Framingham, No. 113, . .	George E. Fay, Framingham.	H. F. Twombly, Framingham.	Mary A. Furber, Saxonville.
Medfield, No. 114, . . .	Mrs. Minnie M. Chase, Medfield.	George R. Chase, Medfield.	Miss Inez R. Clifford, Medfield.
Holliston, No. 115, . . .	J. B. Parkin, Holliston.	Mary E Cutler, Holliston.	Mrs. E. P. Eames, Holliston.
Westborough, No 116, . .	George H Hero, Westborough.	Mary C. Graham, Westborough.	Jennie W. Graham, Westborough.
Dover, No. 117, ...	A. F Smith, Dover.	S. Eudora Shumway, Dover.	Margaret McGill, Dover.
Southborough, No. 118, . .	E. F. Collins, Southborough.	J. E. S. Moore, Cordaville.	Mary C. Collins, Southborough.
Northborough, No. 119. . .	Mrs. Mary S. Wood, Northborough.	Mrs. Sarah J. Carpenter. Northborough.	Mrs. R. N. Mack, Northborough.

Lancaster, No. 120, . . .	W. A. Kilbourn, South Lancaster.	Rev. G. I. Ward, Lancaster.	Mrs. E. T. Cunningham, Lancaster.
Sudbury, No. 121, . . .	L. P. Bent, Sudbury.	Mrs. Frank Bert, Sudbury.	Eleanor M. Gerry, Sudbury.
Templeton, No. 122, . . .	L. W. Bryant, Templeton.	Lucien Gove, East Templeton.	Mrs Mary A. Gove, East Templeton.
Oxford, No. 123, . . .	Herbert E. Lovett, Oxford.	Miss Marion E. Waite, Oxford.	Miss M. B. Fisher, Oxford.
Ashland, No. 124, . . .	James Adams, Ashland.	Mrs. C. E. Adams, Ashland.	Clara E. Cooper, Ashland.
Upton, No. 125, ...	C. M. Wood, Upton.	J. W. Wyckoff, Upton.	Mrs. L. Jenny Chapman, West Upton.
Hubbardston, No. 126, . .	A. L. Potter, Hubbardston.	D. Parsons, Hubbardston.	Eva S. Mason, Hubbardston.
Amesbury, No. 127, . . .	Fred W. Sargent, Amesbury.	Abbie M. Babb, Amesbury.	Nellie A. Huntington, Amesbury.
North Andover, No. 128, . .	W. H Hayes, North Andover.	E. A Fuller, North Andover.	Lizzie F Ingalls, North Andover.
Gardner, No. 130, . . .	A. F. Johnson, West Gardner.	George Gordon, Gardner.	W. E. Knight, Gardner
Boxborough, No. 131, . .	C. T. Wetherbee, Boxborough.	J. F. Hayward, Boxborough.	A. Littlefield, Boxborough.
North Brookfield, No. 132, .	E. A. Harwood, North Brookfield.	Charles Parkman, North Brookfield.	Lizzie A. Doescher, North Brookfield.
West Dedham, No. 133, . .	Charles H. Ellis, West Dedham.	George W. Wetherbee, West Dedham.	H. Elizabeth Fisher, West Dedham.
Berlin, No. 134, ...	Frank H. Crossman, Berlin.	Minnie E. Fay, Berlin.	Carrie P. Jones, Berlin.
Norfolk, No. 135, . . .	G. B. Sims, Norfolk.	Lucy H. King, Norfolk.	Miss Mabel Drayton, Norfolk.
Ipswich, No. 136, . . .	Thomas R. Lord, Ipswich.	Mrs. Alden Story, Ipswich.	F. A Stackpole, Ipswich.
East Blackstone, No. 137, . .	Adrian Scott, Blackstone,	Mrs. Addie Stearns, Blackstone.	Mrs. Nancy Thayer, Blackstone.
Northampton, No. 138, . .	Albert L. Phelps, Northampton	Mrs. D. A. Horton, Northampton	Miss S. E. Mason, Northampton.
East Sandwich, No. 139, . .	Jerome R. Holway, East Sandwich	William C. Fish, East Sandwich	Mrs. Rosa S. Armstrong, East Sandwich.
West Boxford, No. 140, . .	D. Albert Anderson, West Boxford.	Mrs Ella J. Andrew, West Boxford.	Matilda B. Lund, West Boxford.
Montague, No. 141, . . .	F. A. Rist, Montague.	F. L. Whitmore, Montague.	F. A. Dean, Montague.
Bolton, No. 142, . . .	George E. Dow, Bolton.	Marshall Walcott, Bolton.	Mary F. Mentzer, Bolton.
Mendon, No 143, . . .	Albert W. Gaskill, Mendon.	Horace S. Coleman, Mendon.	S. Mabel Spofford, Mendon.
Franklin, No. 144, . . .	John L. Fisher, City Mills.	Mrs. John L. Fisher, City Mills.	S. C. Bourne, Medway.
Douglas, No. 145, . . .	J. A. Williams, East Douglas.	Mary A. Richardson, Douglas.	T. M. Potter, Douglas.
West Newbury, No. 146, . .	Leonard W. Bradley, West Newbury, ...	Mrs J. P. Loring, West Newbury.	Miss Nellie B. Gordon, West Newbury.
West Springfield, No. 147, .	N. T. Smith, West Springfield.	A. A. Sibley, West Springfield.	E. T. Sikes, West Springfield.
Swansea, No. 148, . . .	George W. Arnold, Swansea.	Alice M. Coggeshall, Warren, R. I.	Alice Cleaveland, Swansea Village.
Harvard, No. 149, . . .	S. W. Davis, Harvard.	A. H. Turner, Harvard.	Henry A. Knight, Harvard.
Concord, No. 150, . . .	George P. Davis, Bedford.	Mrs. Addie Garfield, Concord.	George Buttrick, Concord.
Agawam, No 151, . . .	E. L. Covill, Agawam.	Mrs. G D. Fisk, Agawam.	Carrie S. Leonard, Agawam.
East Longmeadow, No. 152, .	J. M. Burt, East Longmeadow.	Mrs. F. M. Lathrop, East Longmeadow.	E. M. Burt, East Longmeadow.
Wilbraham, No. 153, . .	Leroy Smith, Wilbraham.	Mary E. Howard, Wilbraham.	Henry A. Day, Wilbraham.
Haverhill, No. 154, . . .	Isaiah I. Webster, Haverhill.	J. J. Brimblecom, Haverhill.	Susie A. Eastman, Haverhill.
Methuen, No. 155, . . .	C. E. Richardson, Lawrence.	Frank Buckminster, Lawrence.	W. C. Allen, Lawrence.
West Bridgewater, No. 156, .	E. B. Wilbur, West Bridgewater.	B. Ellis Eaton, Brockton.	Charles R. Packard, West Bridgewater.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Concluded.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Granby, No. 157,	George L. Witt, Granby.	George F. Eastman, Granby.	Minnie Whitmarsh, Granby.
"Nemasket" of Middleborough, No. 158,	Charles C. Tinkham, Middleborough.	Mrs. Eldridge Cushman, Lakeville.	John G. Paun, Middleborough.
"Green River" of Williamstown, No. 159,	F. H. Stanton, Williamstown.	Mrs. A. H. Torrey, Williamstown.	Mrs. N. W. Kellogg, Williamstown.
South Hadley, No. 160,	I. N. Day, South Hadley.	C. A. Judd, South Hadley Falls.	Mrs. I. N. Day, South Hadley.
"Laurel" of West Newbury, No. 161,	Samuel Rogers, West Newbury.	Annie L. Rogers, Newburyport.	Gardner S. Bailey, Newburyport.
Dartmouth, No. 162,	John O. Slocum, Dartmouth.	John W. Gifford, South Westport.	Mary R. Crapo, Dartmouth.
Dudley, No. 163,	C. L. Marsh, Webster.	D. S. Elliott, Dudley.	J. J. Gilles, Dudley.
Ware, No. 164,	E. W. Barney, Ware.	J. H. Fletcher, Ware.	Mrs. E. W. Barney, Ware.
Hampden, No. 165,	M. H. Warren, Hampden.	Mrs. F. L. Davis, Hampden.	Mrs. A. J. Tuttle, Hampden.
Wellesley, No. 166,	Charles F. Smith, Wellesley.	Abel F. Stevens, Wellesley.	Carolyn M. Chesbro, Wellesley Hills.
Somerset, No. 168,	Benjamin C. Chase, Somerset.	Joseph Gibbs, Somerset.	S. E. Davis, Pottersville.
Lunenburg, No. 169,	John Wooldredge, Lunenburg.	James L. Harrington, Lunenburg	Mrs. Lucy H. Perrin, Lunenburg.
New Braintree, No. 170,	Geo. H. Thompson, New Braintree.	Mrs. Charles Thompson, New Braintree.	Mrs. Emma More, New Braintree.
Merrimac, No. 171,	Homer B. Sargent, Merrimac.	True Hoyt, Merrimac.	Mrs. L. E. Bartlett, Merrimac.
Ashby, No. 172,	D. H. Damon, Ashby.	Mrs. E. Mayo, Ashby.	William Hayward, Ashby.
Hopkinton, No. 173,	Louis A. Ward, Woodville.	Mrs. Bessie J. Frail, Hopkinton.	A. H. Fitch, Hopkinton.
Brookfield, No. 174,	A. H. King, Brookfield.	W. Mellen, Brookfield.	Sarah C. Mitchell, Brookfield.
Athol, No. 175,	James F. Whitcomb, Athol Centre.	Ivers E. Whitney, Athol Centre.	Mrs. Abbie A. Hill, Athol Centre.
"Miller's River" of Orange, No. 176,	John Dunbar, Orange.	James M. Crafts, Orange.	M. E. Tyrrell, Orange.
Sturbridge, No. 177,	Melvin Shepard, Globe Village.	Ellen Moore, Sturbridge.	C. E. Ainsworth, Sturbridge.
Monson, No. 178,	F. D. Rogers, Monson.	Miss Pearl Beckwith, Monson.	C. C. Keep, Monson.
Ludlow, No. 179,	Frank G. Bennett, Ludlow.	G. D. Atchinson, Indian Orchard.	Ida M. Atchinson, Indian Orchard
West Brookfield, No. 180,	C. S. Johnson, West Brookfield.	Mary E. Fairbanks, West Brookfield.	Jennie C. Preston, West Brookfield
Westport, No. 181,	Marcellus Boynton, Central Village.	Annie F. Jenney, Central Village.	Frances H. Handy, South Westport.
Southbridge, No. 182,	George L. Clemence, Southbridge.	J. E. Clemence, Southbridge.	W. C. Cady, Southbridge.
Andover, No. 183,	J. H. Chandler, Andover.	Mrs. Milo H. Gould, Andover.	Miss Bertha A. Chandler, Andover.
Topsfield, No. 184,	J. A. Lamson, Topsfield.	Wellington Donaldson, Topsfield.	Lillie Donaldson, Topsfield.
North Attleborough, No. 185,	Geo. F. Dana, North Attleborough.	Phoebe Henshaw, North Attleborough.	Jennie Henshaw, North Attleborough.

Fitchburg, No. 186, . . .	W. H. Laws, Fitchburg.	E. A. Hartwell, Fitchburg.	Milton S. Rose, Fitchburg.
"Satuit" of Scituate, No. 187, .	George W. Griggs, Norwell.	Fred J. Corning, Norwell.	C. O. Ellms, Scituate.
Littleton, No. 188, . . .	C. L. Howard, Littleton Common.	M. W. Lawrence, Littleton.	C. F. Watts, Littleton Common.
Warren, No. 189, . . .	W. L. Day, Warren.	H. A. Day, Warren.	W. L. Bridges, Warren.
Bellingham, No 190, . .	C. E. White, Bellingham.	D. N. W. Sanborn, Bellingham.	Mrs Alice Osborne, Bellingham.
Chestnut Hill, No. 191, . .	William O. Burdon, Chestnut Hill.	Mrs. Tiffany, Chestnut Hill.	Mrs. Eda Elsbree, Chestnut Hill.
Winchendon, No. 192, . .	Wallis Sawyer, Winchendon.	C. W. Lord, Winchendon.	John Gregory, Winchendon.
Foxborough, No. 193, . .	James W. Alden, Foxborough.	Albert J. Daniels, Foxborough.	Mrs. J. W. Alden, Foxborough.

APPENDIX.

REPORT.

The following report has been transmitted to the Secretary of the State Board of Agriculture by his Excellency the Governor, with the request that it be included in the "Agriculture of Massachusetts."

Report of the National Farmers' Congress at Sedalia, Mo., Nov. 10–12, 1891.

To His Excellency William E. Russell.

Having accepted the appointment as delegate to the Eleventh Annual Session of The National Farmers' Congress, held at Sedalia, Mo., November 10, 11 and 12 of the present year, it gives me great satisfaction to make a brief report of my action, and the results of the congress to which by your kindness I was appointed with others to represent the Commonwealth of Massachusetts.

I reached Sedalia on the afternoon of November 9, and found a city in the centre of one of the richest and most productive prairies of the great State of Missouri, — a city having already attained a population of about fourteen thousand inhabitants, with regularly laid out streets, many of them well paved and provided with large and handsomely constructed business blocks and public and private buildings. Many delegates from distant States had already arrived, whose acquaintance I had the pleasure of making previous to the opening of the congress.

On the morning of the 10th promptly at ten o'clock the convention assembled; and, the States being called, there responded delegates from thirty different States, to the number of two hundred. Massachusetts and Maine were the only ones represented of the New England States. Philander Williams of Taunton, Samuel Hawkes of Saugus, and myself, were the only delegates present out of the fourteen appointed by your Excellency to represent this State.

The delegates convened in the Grand Opera House, and each delegate occupied a seat indicated by a placard bearing the name of their respective State. The president of the congress, Hon. R. F. Kolb of Alabama, was unable to be present, and Vice-president A. W. Smith of Kansas called the meeting to order and presided over its deliberations. Rev. R. D. Black of Missouri invoked the Divine blessing.

Hon. David R. Francis, Governor of Missouri, delivered an address of welcome, in which he said : " It gives me pleasure to welcome such a representative body of men from all over the United States to the State of Missouri and to the city of Sedalia, representing as they do the agricultural interest, which is the paramount interest of our country, as fully seventy-five per cent of our exports come from the farmers. It is eminently proper that the farmers, the men who represent the greatest interest in the nation, should meet and confer, and discuss the best methods to promote the welfare and the perfection of their interests. There are two great questions in which the farmer should be interested ; one is the improvement of our great water courses, so that we may have cheap transportation for all farm products ; the second is the improvement of the country roads. The National Farmers' Congress can make its interest felt in both these necessary improvements. In behalf of the people of the great State of Missouri I extend to you a hearty welcome. While our State may not rank first in the great cereals, when you take the products of her mines, her agricultural products and her fruit products into consideration, you will find she is in the front rank of the States of the nation. Again I bid you welcome."

Acting-Mayor Carroll of Sedalia then in behalf of the city extended a cordial welcome to this the " Queen City of the West." Being called upon by the presiding officer to respond to this hearty and cordial welcome to the two hundred delegates who represented thirty States of the nation, I expressed my pleasure at this opportunity given to Massachusetts to accept the welcome in behalf of my associates from my own and other States of the Union. I said that Massachusetts recognized no State lines when considering the wealth and business interests of the great republic ; that citizenship in one State of the Union meant protection in every State ; that in this great gathering, in which the Southern and Western States were so largely represented, I could give the fullest assurance that my own State of Massachusetts would be second to no State in anxiety and hopefulness with regard to outcome and results, and that whatever would conspire to the wealth and prosperity and building up of the South and the West would be of equal interest to the great North and East; that Massachusetts, in her ambition for national prosperity, recognized no North, no West, no South, but one great united republic, bearing the stars and stripes of the flag of our union.

In glancing at the past history of The National Farmers' Congress, I find that a session was held in Chicago in 1881; at Indianapolis, Ind., in 1882; at Louisville, Ky., in 1883; at New Orleans, in 1885; at Montgomery, Ala., in 1888, etc. That a constitutional provision for membership authorizes appointment of such a number of delegates as each State and Territory is entitled to in its representation in the Congress of the United States, said delegates to be appointed and commissioned by the governors of the several States and Territories. Agricultural colleges in the several States may each appoint one delegate, and all heads of bureaus of agriculture in each of the United States are members of this organization. Section 12 of the constitution provides that "The Congress of Farmers shall assemble annually, and have full power to discuss, advise and perform other duties that may in their judgment advance the interests of agriculturists of the United States."

The committee on resolutions, of which I had the honor to be chairman, reported in favor of adopting resolutions pledging the organization to maintain its non-partizan character; recommending the deepening and improvement of the Missouri River, also the improvement of the river and harbor of Savannah, Ga.; demanding the passage of laws equalizing the burden of taxation; declaring that the public domain shall be reserved for settlement by citizens of the United States, to the exclusion of foreigners; declaring that national taxation should be limited to the wants of the government, economically and honestly administered; requesting the secretary of agriculture to increase the number of representatives in foreign countries, to push the work of introducing American corn as food; demanding a systematic and thorough improvement of water ways and harbors of the United States; requesting the extension of the free delivery of mail among the farmers; and demanding the control of all trusts and combinations and monopolies, so that they shall work no harm to the people.

These several resolutions were adopted by the convention, copies of which, under the seal of the convention and bearing the attestation of the secretary, Hon. B. F. Clayton of Iowa, were ordered to be forwarded to the members of the National Congress, the President of the United States, heads of departments and governors of the several States and Territories.

The discussion entered into upon these and other questions introduced for consideration was carried on by the delegates in a spirit of candor and breadth of view which indicated a high type of national statesmanship.

Hon. B. F. Clayton of Iowa, who for many years has ably served the Congress as its secretary, was again elected to that responsible position; A. W. Smith of Kansas was elected president, Hon. William Freeman of Maine treasurer, and Hon. D. G. Purse of Georgia first vice-president.

The concluding business of the convention, at the close of its three days' session, appears in the following preamble and resolutions: —

Whereas, The success of the National Farmers' Congress of the United States in securing the passage of the interstate commerce law, the enlargement of the signal service, the making of the secretary of agriculture a cabinet position, and the prominence given to various other questions touching monopolies, trusts, combinations and unjust discriminations, has been largely because of its non-political position; and

Whereas, Believing that future legislation, State and National, for the benefit of the productive and industrial interests of the country, can be more readily secured through non-partizan organization; therefore

Resolved, By the National Farmers' Congress of the United States, assembled in the eleventh annual session at Sedalia, Mo., Nov. 12, 1891, that, while we reserve the right to discuss men and measures, we will not lose sight of the principles of our constitution, the object of which is to "advance the agricultural interests of the nation."

Resolved, That, believing greater good can be accomplished by extended representation, we cordially invite and request every State, county and district agricultural society in the United States, and all boards of trustees of such societies, agricultural colleges and experiment stations, to appoint one or more delegates to a non-partizan national convention, to be held in conjunction with and as a part of the twelfth annual session of this body, at Lincoln, Neb., on Tuesday after the national election in 1892.

Resolved, That a copy of these resolutions be sent to the secretaries of the various agricultural societies and organizations, and that they be requested to appoint delegates and make provision for their necessary expenses.

Resolved, That we respectfully request that all railway, passenger and traffic associations, in lieu of the one and one-third fare now granted, be reduced to one fare for the round trip to all who wish to attend such congress or national convention, thus placing the agricultural interests on the same footing with other national conventions.

Among the prepared addresses there should be mentioned one by the Hon. Wm. Freeman of Maine, upon "The Relations of the Farmer to the Manufacturer and Organized Bodies." This address was listened to with great interest, and had been prepared after careful study.

On the morning of the second day Hon. I. S. Hall of Missouri spoke upon the question, "Have the Farmers a Right to Complain?" As the farmers enjoy citizenship and suffrage with men of all other occupations, he considered the remedy in their own hands.

Hon. George G. Vest, United States Senator from Missouri, spoke upon "National Agriculture and its Great Outlook." On the afternoon of the second day the Hon. M. Mohler, secretary of the State Board of Agriculture of Kansas, delivered an address upon "The Race under Conditions of High Civilization," in which he undertook to show that moral strength was not necessarily a result of high intellectual attainment. The same afternoon the Hon. J. M. Stahl of Illinois delivered an exhaustive address upon "The Transportation of Foreign Products." Hon. John T. Henderson of Arkansas on the morning of the third day delivered an address upon "The Jersey Cow."

The citizens of Sedalia lavished many pleasant hospitalities upon the visiting delegates. The pyrotechnic display of the Flambeau Club on the evening of the second day won the admiration of all the visitors. The Sedalia Rifles on the same evening gave a public exhibition of their drill.

The closing hour of the convention, devoted to handshaking and personal last words, was evidence of the establishment of new social ties which will do much toward securing a truer knowledge of relations between people of a common country separated by distant States.

DANIEL NEEDHAM,
Delegate.

CATTLE COMMISSIONERS' REPORT.

To the honorable Senate and House of Representatives of the Commonwealth of Massachusetts, the undersigned Cattle Commissioners present their report for the year ending Dec. 31, 1891.

Throughout the year the general condition of our domestic animals has been good. They have not been subjected to any prevailing epidemic or contagion, and the sporadic cases, though large in the aggregate, were but a very small per cent of the whole. Foot and mouth disease, Spanish fever and contagious pleuro-pneumonia have not afflicted them, and the diseases mentioned in our last report are the only ones with which we have had to contend, and in relation to which our regulations published a year ago are yet in force.

Glanders.

The peculiarities of the prevalence of this disease, which have been previously brought to your notice, have been more marked during the last than any previous year. There have been reported to us but two cases west of Worcester County, none from Barnstable, Dukes or Nantucket; but in localities in the counties of Essex, Suffolk, Norfolk, Middlesex, Bristol and Worcester, it has been very prevalent. The whole number of cases we have caused to be destroyed in accordance with the provisions of law, or by the voluntary act of the owner after being convinced of the nature of the disease, has been 157, which is nearly double the number destroyed in any previous year. Some of these cases were of horses recently brought into the State, and others were traceable to contagion disseminated by such animals.

Through fear of injury to their practice, or from some other cause, there is an inexcusable if not criminal laxity with some veterinarians in reporting to their boards of health cases of this disease which come to their knowledge. A veterinarian of Taunton reported to us that he knew of twenty-four cases in that city, of which but five had been reported; and another in West Newton reported that he knew of five cases, of which but two had been reported. It is not unfrequent that cases of the disease are reported, and the information given that the animal has been killed and nothing need be done. If such reports are true, if the veterinarians are honest with the public and themselves, the spirit of the law is complied with, and the nuisance abated quicker than it could be done by statute provision. But the danger in the case is, that all veterinarians will not be honest in this regard; and the animal, not having been placed under the control of the board of health of the locality, may be so treated by quacks or others as to disguise the disease, and then traded to some unsuspecting person, to his loss, and the creation of a new centre of infection. That this has been done we have every reason to believe. From the most reliable source we have been informed that a horse-trading quack of the town of Amesbury had, on a certain occasion in the month of August last, boasted that first and last he had got more than a hundred glandered horses from Brighton and vicinity, "fixed them up and shoved them." We have found great difficulty in securing evidence which would convict in court for such illegal transactions, and solicit information in this regard from all good citizens who respect law and desire the public welfare.

We desire again to call public attention to the fact that this is a contagious, loathsome and incurable disease, which may be contracted by any person who has the care of, or comes in contact with, such diseased animal; and the utmost caution should be exercised by those who must care for them, until they can be destroyed. The ordinary symptoms which indicate this disease are a disturbance of the lymphatic system, an induration of the sub-maxillary gland, a straw-colored, sticky nasal discharge, and ulceration of the mucous surface of the septum.

But in many cases all these evidences are not fully developed, and great caution is required that a mistake is not made, and an animal needlessly condemned. In the discharge of our duty cases of this kind have occurred which illustrate this uncertainty. One, the noted Cambridge horse-railroad case of 1887 and 1888, where, out of a total of 1,800 animals, many most excellent veterinarians adjudged that nearly seventy were surely glandered. This opinion was combated by a majority of our Board, and the horses released from quarantine. Measures were taken to receive information from the released animals for two years, and, so far as known, not a case of glanders has developed. The animal which was thought to present the clearest evidence of disease is at this date owned by the company, is performing heavy work, and is in perfect health. Another case occurred at Rehoboth, in 1888, which illustrates this uncertainty. Dr. J. F. Winchester, then the veterinarian of this Board, was notified by the board of health of that town that they had placed in quarantine the horse of one Miller, suspected of being infected with glanders. The doctor examined the case, and reported that, in his opinion, it was unmistakably glanders. The animal was condemned, and an order for its destruction issued, which was executed by one Horton, a selectman of the town. Subsequently Miller sued Horton for damage, and the case came to trial before the court at Taunton. The finding of the court was that the horse was not glandered, but at a second trial the decision was rendered that it was glandered.

Hog Cholera.

During the year we have been frequently notified of suspected cases of this disease, some of which, however, were other diseases of similar type. The complaint is rife among swine herds at the West, and discussions and investigations are continued in relation to its distinctive characteristics, and the nice technical differences between this and some other forms of disease to which swine are liable; but nothing specially new in this line has been discovered, or in that of giving exemption from the disease. There is much less of it in our State now than four or five years ago; but the causes which produce it here remain practically the same, and have been given in detail in previous reports. We therefore consider it wise that the regulations regarding its treatment, which we have sent to all our municipalities, should remain in force.

Bovine Tuberculosis.

Though certain forms of lung trouble among our cattle had been previously reported upon by our Board, the first specific report on this disease was made in 1880, and it has been discussed, and information respecting it given, in each of our reports since 1886. It has been our earnest endeavor, each year, to make a complete survey of the entire field and all the stock committed to our oversight; to report the exact facts obtained by our observations in relation to the extent to which the disease prevails, and the danger therefrom to our people by the consumption of our stock products; and to do this without any regard to alarmists who, on the one hand, are apparently endeavoring to make business and money for themselves by circulating sensational reports; or, on the other, to those who declare there is no such disease or danger, that they may be unchecked in the sale of milk or meat, however infected it may be. In our last report we discussed this whole matter at considerable length, and quoted from an article on "The present attitude of veterinarians on the subject of tuberculosis," by Dr. Daniel D. Lee, instructor of anatomy in the veterinary department of Harvard University. In this article he quotes the opinion of Professor Airlong, an authority on this subject, "that tuberculous milk and meat is the least important source of this contagion," and that "only about five in a thousand is the number of tuberculous cattle found." He says, "The chief source of danger, both in animals and men, lies in the inhalation of dust containing the dried sputa, in those localities where the population is dense and the disease prevalent." And again he says, "I enter a plea that the severity of the crusade against our cattle be somewhat lessened, until some steps are taken by the medical profession and boards of health to quarantine human beings suffering from tuberculosis." He closes his article as follows: —

I wish it understood that I believe tuberculosis to be a very contagious disease, but slow in its course. Every one will acknowledge that the danger from the milk and meat is the *very least.* The milk is diluted by that of healthy cows, under which circumstances even direct inoculation often fails; and the meat is only diseased in five cases in one thousand, and then is generally cooked. The danger from inhalation of dried sputa in the dust is very great either from man to man, or man to animals. Therefore, let us wait a little before we condemn all the cattle and other diseased animals; for, even if we eradicate the disease among them themselves, they will contract it again from man.

Our experiences and investigations during the last year have only served to strengthen and confirm the opinions expressed in our last annual report, as well as those of Dr. Lee, here given. In an essay read by Dr. Chapin of the city of Springfield before a convention of the boards of health of the State, last October, giving an account of his investigations on tuberculosis in that city, and extending over a period of twenty-five years, he gives an opinion based on those investigations, that there was much more danger that our cattle would contract the disease from man than that man would contract it from them. In consequence of unfavorable surmises respecting the condition of the herds of cows which supplied the city of Worcester with milk, the Board visited that locality last March, and examined twenty-five herds, containing 850 cows. With perhaps one exception, the sanitary condition, surroundings and food of these herds was of the best, and the animals were apparently in perfect health. We found but one animal which had fallen under suspicion of disease; but a careful examination of it by auscultation, percussion and taking of temperature, did not disclose it. She was in prime good condition, and we learn was killed for beef about two months afterwards; and no fault was detected in the carcass. The owners of these herds did, and had occasion to, pride themselves on the condition of their animals, and the consumers of their milk may have perfect confidence in its excellence. During the year a record has been kept of 200 cows slaughtered for beef in the vicinity of Marlborough, and but two per cent were found unfit for human food in consequence of diseases of all kinds. Similar cases to the above have fallen under our observation in different parts of the State. But tuberculosis does exist here among our cattle, though not to such an extent as to cause serious alarm or justify their indiscriminate slaughter, or our total abstinence from the consumption of their milk and meat.

As a measure of precaution, and to keep it in abeyance, we recommend the continuance of the rules and regulations published in our last report. In order to secure the inspection of animals intended for slaughter, and of all provisions offered for sale, we recommended in that report that all our towns by vote at their last annual meetings accept of the provisions of chapter 58 of the Public Statutes, which would give their selectmen power to appoint such inspectors. The recommendation was not heeded; we now therefore recommend to the Legislature the passage of an act similar to the last clause of section 13 of our contagious disease law relating to glanders. This would give the commissioners power to forbid the sale of tuberculous cattle, to cause their destruction, and to prevent the sale of milk and meat containing the germs of the disease.

We might here close our report on this part of our duty but for the fact that a very serious if not invidious attack has recently been made upon Massachusetts by the Cattle Commissioners of the State of Maine. By a report from that State, published in the "Boston Herald" of the 23d ult., it appears that that board, empowered, as they suppose, by a law of their State, have declared it "a crime to do business in Massachusetts cattle," and that "the importation of a single cow, no matter of what breed, from Massachusetts, is absolutely forbidden." That board, it appears, was led to take this action from the statements of one Geo. H. Bailey, their veterinarian, which were as follows: "That the Crowley Brothers of Lisbon, that State, had recently imported there several car-loads of cheap cattle from Brighton, Mass., which he had caused to be killed, and found them badly infected with tuberculosis." He further says, "Massachusetts does not attempt to stamp out this disease, and the condition of affairs in that State are simply shocking; that that State is fairly honeycombed with diseased cattle." It should be noticed that Dr. Bailey does not claim that he has made any personal examination of the home cattle of our State, but only of "cheap cattle brought from Brighton." He does, however, quote Dr. J. F. Winchester of Lawrence, Mass., who has already been alluded to in this report, and whose statements should be carefully dissected and compared before full credence is given them. This is not the first time that this Dr. Bailey has made the most sweeping charges against the entire cattle stock of this State, and drawn his proof of them from the same source as now, viz., "cheap cattle from Brighton, and Dr. Winchester of Lawrence."

It ought to be sufficient for us to say that the charges against Massachusetts cattle by Dr. Bailey are untrue, and to refer to facts already given in this report as proof. But it is perhaps better that we shall allude to the legal attitude of the Cattle Commissioners of Maine, and quote from the latest reports at hand of the inspection of Massachusetts cattle and their products on a large scale to sustain them. The law of Maine above alluded to, and of which the Cattle Commissioners or Dr. Bailey are presumably the authors, is no law at all, and it is not a "crime" to import cattle from Massachusetts or any other State into Maine. Massachusetts and nearly all States westward to Kansas once committed that folly, and in 1875 passed similar acts to prevent the introduction to their States from Texas of cattle infected with Spanish fever. In the State of Missouri this law was contested, and a case brought before the United States Court, where the law was declared unconstitutional, because it attempted to interdict or control commerce between the States, which was a power conferred by the Constitution only upon Congress. Massachusetts and other States then passed enactments substituting quarantine of suspected animals when found within the State. If Maine and Dr. Bailey are still in the Union, they must be amenable to its constitution, and be careful about arrogating to themselves the powers of Congress, especially in going so far as to declare what shall be "a crime, with a penalty attached." Dr. Bailey may possibly be familiar with the cattle and the cattle trade of Maine, removed as it is from the great lines of trade and transportation of these animals; but he exhibits a gross ignorance in this regard of the conditions which do and must exist in Massachusetts.

Brighton and Watertown in this State, to which Maine exports, and from which she imports "cheap cattle" are two of the great collecting and distributing points of cattle for the whole country. Hundreds of thousands of animals are gathered here from all the New England, northern and western States and Canada, and either slaughtered here or taken abroad to other countries and States, including Maine. While here, these animals are only in transit for their real destination, or waiting for slaughter; and while here they very rarely affiliate with or become a part of our home stock. Tuberculosis exists both in men and bovines over the entire country from which these animals are gathered, and it would be very strange if an animal thus affected was not occasionally found among them, or if the Crowleys of Maine, in buying "cheap cattle at Brighton," did not get some of them. Maine is a large contributor weekly to the stock market of Brighton, and she has tuberculosis among her home stock; and it would not be strange if she contributed her mite to increase the volume of this pest of "cheap cattle" said to be found there. The facts gathered weekly show that Maine is a larger contributor to that market than Massachusetts. For the week ending December 24 last, there were in that market 2,143 cattle. It being Christmas week the number of cattle from abroad was very small; but, of the whole number stated, Massachusetts furnished 39 and Maine 104. The size of this market varies somewhat from week to week, but the comparison between the two remains practically the same through the year.

With the above facts and conditions in mind, it is well to consider the unreasonableness if not falsity of the charge of Dr. Bailey, "that, while Maine some ten years ago awoke to the realization of the danger to humanity from this dread disease, and has since actively tried to stamp it out and has practically succeeded, Massachusetts does not attempt to stamp it out, and does not spend a single dollar to accomplish so desirable an end." The people of Massachusetts and its Cattle Commissioners are perfectly familiar with the process and cost of "stamping out" cattle disease, and the Cattle

Commissioners of Maine might be grateful to them for the lesson we have taught them in this regard, and thankful that, from their comparative isolation and distance from the great lines of cattle transit and market, it may be possible for them to accomplish something by the process, though infection will infallibly reappear in consequence of the existence of the disease among her human population.

With existing conditions in Massachusetts, which it does not appear to be within the range of human possibilities to change, to stamp out this disease, as recommended by Dr. Bailey, would be for us to kill and pay for all the cattle of the northern and western States and of Canada which come to our market for sale and distribution, as well as our home stock. This cannot be done, and would not eradicate the disease if it could, because, as in Maine, contamination of the cattle would follow from the presence of the disease in our human population. For these reasons our Board has believed our wisest as well as really our only course to combat this disease was by elimination in accordance with the rules and regulations published in our last report, and by preventing the sale of milk and meat which might possibly be infected. But does tuberculosis prevail in Massachusetts, taking into account both its home stock and that which is brought here for slaughter and is in transit, to such an alarming extent as is represented by Dr. Bailey? To again give an answer in the negative, we here introduce the testimony of the inspectors to which allusion has been made. Dr. Bryden of Boston, the inspector of live cattle and dead meats exported from Boston by the British steamships, makes the following report on his own work and that of Dr. Alexander Burr, inspector of dead meat for the Board of Health of the city of Boston, and which was published in the "American Cultivator" of Jan. 3, 1891. After alluding to the reported condition of market stock in this country and Europe, he says: —

My contention is that about five per cent of the cows in the neighborhood of our large cities, with two per cent of cows, calves, oxen and other cattle in country districts, is sufficiently sensational and alarming, and an estimate that will more than cover the cases of tuberculosis among the cattle population of Massachusetts, excepting perhaps among the old cows that die in the neighborhood of our large cities; while, with reference to the cattle population of the United States, not one per cent are tuberculous. This conclusion is arrived at by me from the following data and experiences.

I have been in general veterinary practice in Boston for twenty years, and, in connection with this, live-stock and dressed-beef inspector at Boston for several of the largest British steamship lines that come to this country for the last ten years. I have yearly inspected from 25,000 to 75,000 head of cattle up to last year, and over 100,000 head this year (1890), and within six months 3,000 quarters per week of dressed beef in addition.

This embraces cattle from Canada and the northwestern States, cattle from the eastern and the middle States, the South and the West: cattle of all ages, steers, bulls, cows, stags, oxen, heifers and calves; distillery-fed, slop-fed, corn-fed and grass-fed; many of them as high and fine-bred animals as there can be found in all the world. If the disease is present to the extent stated, why has it not been found among those that died in transit here, or at the stock yard? Why have not the English butchers and inspectors reported it oftener? A few cases of actinomycosis, Texas fever, anthrax, and two cases of an uncertain lung disease, are the only diseases worth mentioning I have ever met with among our export animals.

In my regular veterinary practice I occasionally find cases of tuberculosis, mostly within the last five years; but not to any such extent as reported, unless dairies of two cows, or herds of five, in certain cow-houses, are meant to prove the large percentage, when one or two of their number are diseased; neither am I ready to admit that the cows in the neighborhood of the old cities of Europe are healthier than ours.

I am also indebted to the Board of Health of Boston for their latest reports. Dr. Alexander Burr, their dead-meat inspector, has kept an exact account of all the cattle slaughtered at the Brighton Abattoir during the year 1890. The largest percentage of tuberculosis he finds among Eastern cows, where it reaches from three to four per cent; this shows that our cows are as healthy as those of some of the cities of Europe, even where the sanitary regulations are excellent, and have been for years, for their statistics are taken from the dead animal. They do not regard a high-bred herd infected because one or two of its number have been; and at the international meeting these statistics were meant to embrace only those actually diseased.

Among the dead cows in the vicinity of Boston sent to the knackers department to be made into fertilizers, he found 7.5 per cent. Certainly no place could be found where the percentage could possibly be higher, or more unfair as a basis from which to calculate the condition of either the cows or the cattle population.

While it might be that abattoir figures would be slightly favorable, that could not possibly be the case with this class of animals. Among Western cattle he has found only one case of tuberculosis. One of his reports to me was for ten weeks last year, when he found, among 7,000 cattle slaughtered, only seven cases of tuberculosis. His next report to me was for six months. Out of 15,506 cattle slaughtered, he found only .17 (or 17-100ths of one per cent) tuberculous. Of the above number, 810 were Eastern cows; of these, 3.30 per cent were tuberculous; while among eighty dead cows carted in for fertilizers from the vicinity of Boston, six were found to be tuberculous.

My reason for challenging the statements made in the Review editorial is because they appear to me entirely wrong and unfair to the country, especially when read in foreign countries, where our products are objected to on account of their supposed diseased condition. It interferes with the business of the steamship lines coming here, it injures the stock raisers and shippers, and must be embarrassing to the Bureau of Animal Industry at Washington, which is now doing so much to remove this wrong impression abroad. WILLIAMSON BRYDEN, V. S.

Inspector for British Steamships.

Can these statements of Drs. Bryden and Burr be disproved by Dr. Bailey of Maine and Dr. J. F. Winchester of Lawrence, Mass.? If not, then there is no present cause for alarm, and the measures of the cattle commissioners, if carried forward, will accomplish all that under present conditions is possible.

We have already alluded to the sensational character of the reports which have been circulated respecting our cattle. This is apparent by the language and terms which are used in speaking or writing of it, such, for instance as "dread disease," "most alarming," "shocking," "stands appalled," and the like. It would appear as if these men thought themselves to be the discoverers of the disease, that *they* only knew its character, and therefore felt it necessary to use the strongest, most stirring words found in or which could be coined from the English language, to arrest public attention and direct it to an impending calamity; whereas, the *fact of the disease*, and all the details of its development and results, were thoroughly well known and understood hundreds of years before their grandfathers were born. It may not have been classed among contagions; but, if it is contagious now, it always was, and always was as dangerous as now, no more and no less. In truth, as many facts can be gathered to prove that it is not contagious, as can be found to prove that it is. But we will admit it to the list of contagions. What then? Contagions differ amazingly in their virility, certainty and mode of transmission, ease with which they may be resisted, period of incubation, etc. Tuberculosis in action is one of the weakest, slowest and most easily averted of any known. When compared with small-pox, yellow fever, measles or diphtheria in man, or foot and mouth disease, Spanish fever, or contagious pleuro-pneumonia in cattle, it hardly deserves to be called a contagion. Rare indeed are the cases of it, both in men and cattle, where the causes of it cannot be traced directly to colds resulting from sudden changes of temperature, confinement in foul air without suitable ventilation, and these combined with weakened vitality, caused by over-breeding, over-working and improper feeding; and this, it is to be noted, is where the principle of this contagion, if it has played any part in the calamity, cannot by any possibility be traced to an origin in any other animal.

As a simple contagion, therefore, or because it is considered such, it is not to be accepted as a "dread disease." As a contagion, it has a germ floating in air, swimming in water, or concealed in our food; but there is no occasion to be "appalled" on that account, for the same is true of measles, chicken-pox, diphtheria and other diseases, and this is the weakest in vitality, and more dependent on a variety of extraneous circumstances for its development than any of them. True, if a contagion, it has a germ or seed; but, that it may grow and cause what is called disease, it must be planted in ground fitted for its reception by a union of many of the conditions which have been named, and over which we have nearly perfect control. It has a germ which can be found by searching with microscopic power, and which, if fed to animals for consecutive weeks or months, or forced into their blood, may be made to incubate; but this process is purely artificial, simply showing what scientific skill may accomplish. It is utterly unlike the processes of nature in the movement of the germ from subject to subject, where a personal defence can be made, or, if need be, assistance given in prevention or resistance.

Again, uneasiness if not alarm has been created by the oft-repeated statement that this disease is certainly hereditary. Facts to contradict this are abundant and pointed. At the present time investigators are quite generally agreed that an animal born of a tuberculous mother does not carry the germs of the disease in its system, but that, being born of a parent with a weakened constitution, it has a predisposition to disease, and, when called on in after life to perform unusual over-taxing labor, or when exposed to the unfavorable surrounding conditions we have named, this, or, in fact, any other disease, is liable to occur. Here, too, by intelligent care and foresight in relation to the required labor and conditions, the feared result may be averted.

Rabies.

The rules and regulations for the control and diminution of this disease, of which you were informed in our last report, and which were afterwards sent to all the towns and cities of the State, have been continued, and will not be rescinded at present, or until there is a change for the better in the prevalence of the contagion. If, however, they are productive of good, there is but little evidence of it. Several cases of the disease in animals and men, the result of the bite of rabid dogs, have been called to our notice, but only after the harm had been done, the offending animal killed, and the danger practically past. There are not a few of these cases in the State in the aggregate, — as many, probably, as of tuberculosis which can be positively traced to the consumption of infected meat and milk; but in the country at large they are so rare, their premonitory symptoms so little understood, and they run their course so quickly, that boards of health and their executive officers meet with little success in getting control of them. An active constable with a shot-gun is an excellent preventive of the spread of this disease, and is recommended when the commissioners cannot be immediately reached.

LEVI STOCKBRIDGE,
A. W. CHEEVER,
O. B. HADWEN,
Cattle Commissioners.

BOSTON, Jan. 6, 1892.

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NINTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

STATE AGRICULTURAL EXPERIMENT STATION

AT

AMHERST, MASS.

1891.

BOSTON:
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1892.

Commonwealth of Massachusetts.

Office of the Secretary, Boston, Jan. 14, 1892.

Hon. William E. Barrett, *Speaker of the House of Representatives.*

Sir: — I have the honor to transmit, for the use of the Legislature, the Ninth Annual Report of the Board of Control of the State Agricultural Experiment Station.

Very respectfully,

ISAAC H. EDGETT,
Deputy Secretary.

Boston, Jan. 13, 1892.

To the Honorable Senate and House of Representatives.

In accordance with chapter 212 of the Acts of 1882 I have the honor to present the Ninth Annual Report of the Board of Control of the State Agricultural Experiment Station.

WM. R. SESSIONS,
Secretary.

MASSACHUSETTS STATE
AGRICULTURAL EXPERIMENT STATION,
AMHERST, MASS.

BOARD OF CONTROL, 1891.

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T. P. Root of Barre, ... Term expires, 1891.
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C. S. Crocker, B.S.,	“ “ “ “
B. L. Hartwell, B.S.,*	“ “ “ “
H. D. Haskins, B.S.,	“ “ “ “
C. H. Jones, B.S.,	“ “ “ “
F. L. Arnold, B.S.,	“ “ “ “
C. H. Johnson, B.S.,	“ “ “ “
W. A. Parsons, B.S.,	*Field Experiments and Stock Feeding.*
David Wentzell,	*Farmer.*

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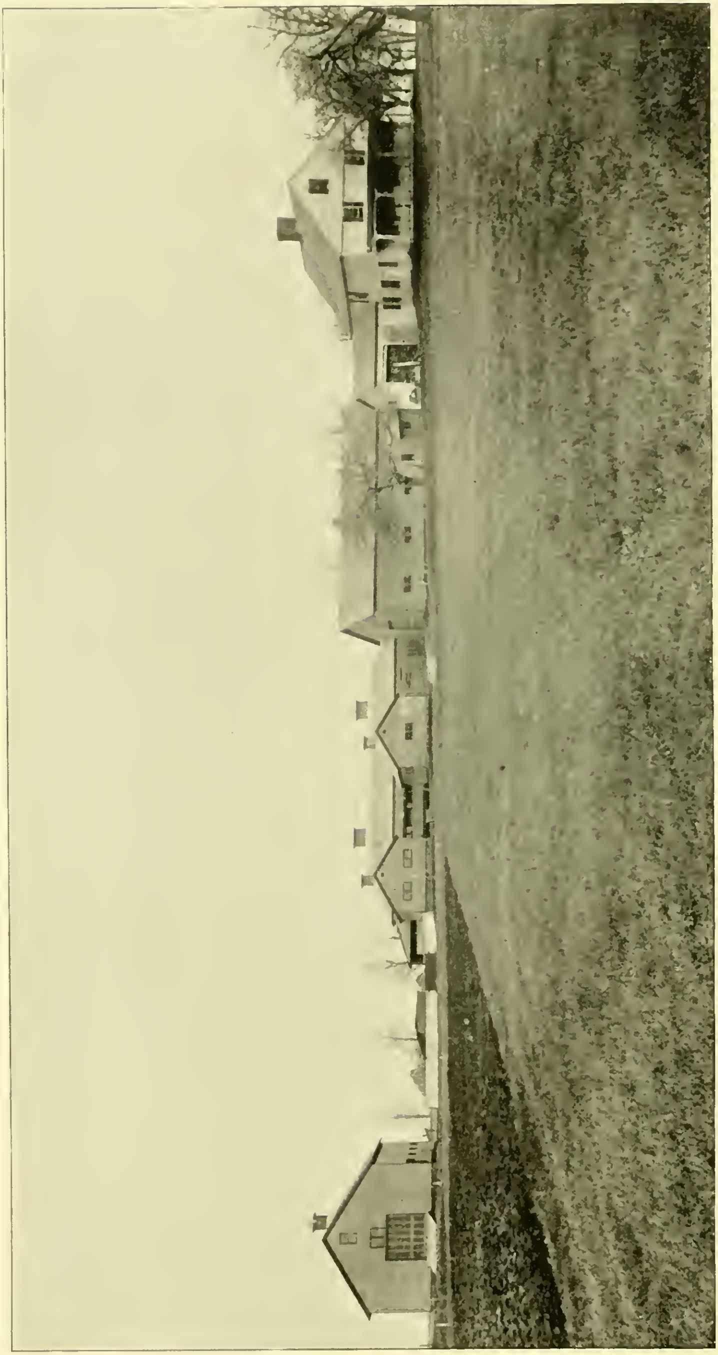
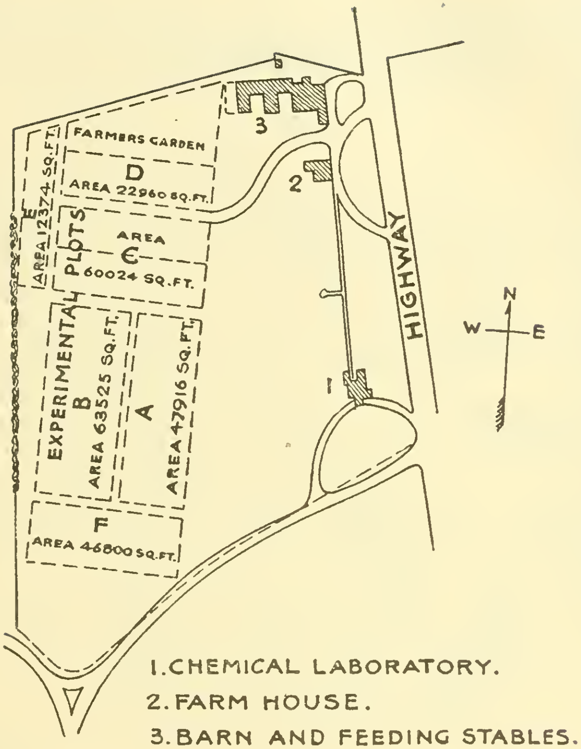
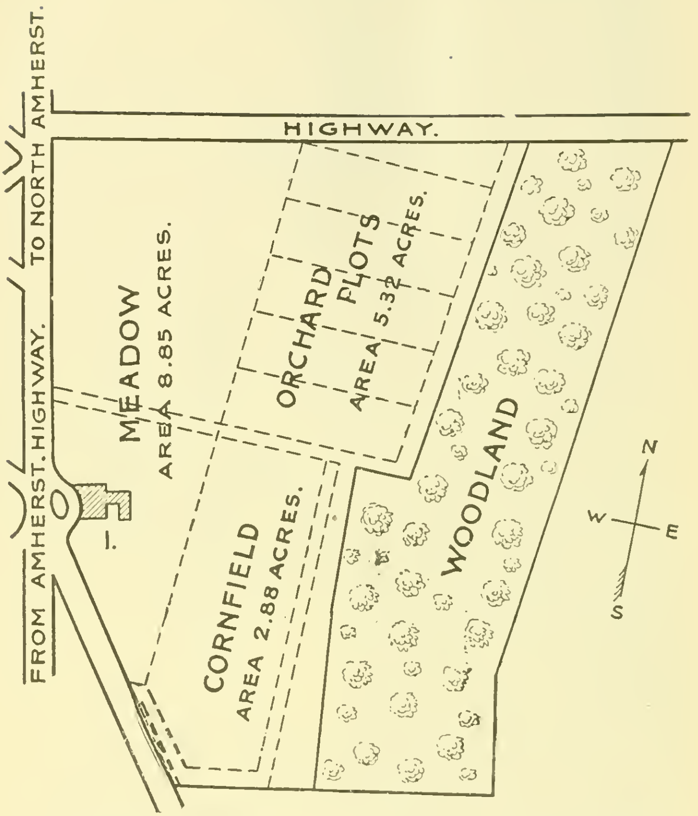
* Resigned June 1, 1891.




3
FARMERS GARDEN
D
AREA 22960 SQ.FT.
2
E
AREA 12374 SQ.FT.
EXPERIMENTAL PLOTS
AREA
C
60024 SQ.FT.
HIGHWAY
N
W
E
B
AREA 63525 SQ.FT.
A
AREA 47916 SQ.FT.
1
F
AREA 46800 SQ.FT.
1. CHEMICAL LABORATORY.
2. FARM HOUSE.
3. BARN AND FEEDING STABLES.

·MAP·OF·LAND·LEASED·TO·THE·
·MASSACHUSETTS·EXPERIMENT·STATION·
·FROM·THE·
·AGRICULTURAL·COLLEGE·FARM·
·WEST·OF·THE·HIGHWAY·
·AREA·TAKEN··17.72·ACRES·


TO NORTH AMHERST.
HIGHWAY.
FROM AMHERST. HIGHWAY.
MEADOW
AREA 8.85 ACRES.
ORCHARD PLOTS
AREA 5.32 ACRES.
CORNFIELD
AREA 2.88 ACRES.
WOODLAND
1.
N
W
E
S

1. AGRICULTURAL & PHYSIOLOGICAL LABORATORY.

MAP·OF·LAND·LEASED·TO·THE
MASSACHUSETTS·EXPERIMENT·STATION
·FROM·THE·
AGRICULTURAL·COLLEGE·FARM
EAST·OF·THE·HIGHWAY
AREA·TAKEN·30.52·ACRES

NINTH ANNUAL REPORT OF THE DIRECTOR

OF THE

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

To the Honorable Board of Control.

Gentlemen: — The past year has been a prosperous one in the history of the Massachusetts State Agricultural Experiment Station.

The buildings have suffered no injury from any exceptional source and are in a well-preserved state, considering their respective age and previous condition.

The construction of a new barn, for storing separately in a desirable manner the products of the different experimental plats, has filled a serious want.

A favorable season has aided materially in a successful termination of a variety of field experiments as well as in a satisfactory general management of the farm work.

The different lines of investigation presented from time to time for your consideration have received their due attention as far as circumstances have rendered practicable. The amount of work accomplished in the field, the barn and the chemical laboratory compares well with the results of previous years. The introduction of the vegetation house for the purpose of studying, under well-defined circumstances, the influence of special articles of plant food on the growth and character of plants, besides other intricate questions of vegetable physiology, has added an important feature to our resources of efficient methods of observation for the advancement of an economical production of farm crops.

Prof. J. E. Humphrey has continued his observations regarding various diseases of fruit-trees and garden crops. An interesting description of his investigation during the past year forms part of this report (Part II. 9).

The details of the work carried on during the past year, 1891, are reported upon subsequent pages in the following order: —

PART I.

ON FEEDING EXPERIMENTS — 1891.

I. FEEDING EXPERIMENTS WITH MILCH COWS (three).
II. FEEDING EXPERIMENTS WITH STEERS.
III. FEEDING EXPERIMENTS WITH LAMBS.
IV. FEEDING EXPERIMENTS WITH PIGS (three).

I.

Feeding Experiments with Milch Cows — 1891.

1. Feeding experiments with milch cows: Old-process linseed meal *vs.* gluten meal (Chicago).
2. Feeding experiment with milch cows: Gluten meal (Chicago) *vs.* cotton-seed meal and old-process linseed meal.
3. Summer feeding experiment with milch cows: Green feed, — vetch and oats, soja bean and fodder corn. Grain feed, — corn meal, gluten meal (Chicago), with dried brewers' grain *vs.* wheat bran.
4. Creamery record of the station for 1890 and 1891.
5. Fodder analyses and valuation of fodder.

PART II.

ON FIELD EXPERIMENTS, AND OBSERVATIONS IN VEGETABLE PHYSIOLOGY AND PATHOLOGY.

1. Effect of different kinds of nitrogen containing manurial substances on the yield of rye (Field A).
2. Experiments with prominent varieties of grasses and with grass mixtures to ascertain their comparative economical value under fairly corresponding circumstances (Field B).
3. Experiments with reputed fodder crops mostly new to our locality, and with a series of garden crops treated with different mixtures of commercial fertilizing ingredients (Field C).
4. Experiments with raising Stowell's evergreen sweet corn for ensilage (Field D).
5. Experiments with different commercial phosphates to study the economy of using natural phosphates or acidulated phosphates in farm practice (Field F).

6. Experiment with a Western variety of dent corn, Pride of the North, for ensilage (Field G).
7. Experiments with grass lands (meadows).
8. Report on general farm work in 1891.
9. Report of Prof. James Ellis Humphrey on plant diseases, etc., with observations in the field and in the vegetation house.

PART III.

SPECIAL WORK IN THE CHEMICAL LABORATORY.

I. Communication on commercial fertilizers: —

  1. General introduction.
  2. Laws for the regulation of the trade in commercial fertilizers.
  3. List of licensed manufacturers.
  4. Analyses of licensed fertilizers.
  5. Analyses of commercial fertilizers and manurial substances sent on for examination.
  6. Miscellaneous analyses.

II. Water analyses.

III. Compilation of analyses made at Amherst, Mass., of agricultural chemicals and refuse materials used for fertilizing purposes.

IV. Compilation of analyses made at Amherst, Mass., of fodder articles, fruits, sugar-producing plants, dairy products, etc.

Meteorological Observations.

The periodical publications of the station have been as numerous as during previous years. The applications for copies of bulletins and annual reports are steadily increasing. Our supply of bulletins I to XXX and of annual reports I to VI is exhausted.

In concluding this communication it gives me pleasure to acknowledge the industry and faithful assistance of all parties associated with me in the task assigned. With sincere thanks for your kind support and indulgence allow me to sign,

Yours very respectfully,

C. A. GOESSMANN,

Director of the Massachusetts State Agricultural Experiment Station.

PART I.

ON

FEEDING EXPERIMENTS,

1891.

I. Feeding Experiments with Milch Cows (three).
II. Feeding Experiments with Steers.
III. Feeding Experiments with Lambs.
IV. Feeding Experiments with Pigs (three).

I.

FEEDING EXPERIMENTS WITH MILCH COWS.

1891.

General introduction to our late feeding experiments with milch cows.

I. Feeding experiment with milch cows: Old-process linseed meal *vs.* gluten meal (Chicago variety).

II. Feeding experiment with milch cows: Gluten meal (Chicago variety) *vs.* cotton-seed meal and old-process linseed meal.

III. Summer feeding experiment with milch cows: Green feed, — vetch and oats, soja bean and fodder corn. Grain feed, — corn meal, gluten meal (Chicago variety), with dried brewers' grain *vs.* wheat bran.

IV. Creamery record of the station for 1890 and 1891, with a description of modes of analysis.

V. Analysis of fodder and valuation of fodder.

General Introduction. — In summing up in our late annual report the principal results obtained in connection with a series of feeding experiments with milch cows, carried on from 1885 to 1889 at the Massachusetts State Agricultural Experiment Station, special attention was called to the fact that until quite recently our main object has been to compare the economical value of some of our most prominent current *home-raised coarse fodder articles* when used for dairy purposes. English hay, rowen (hay of second cut of upland meadows), dry fodder corn, corn stover, corn ensilage and several varieties of roots (sugar beets and carrots) were the fodder articles of that description used. They were fed as far as practicable under otherwise corresponding circumstances.

To attain this end it became necessary to use in all cases alike the same kinds and the same quantities of grain feed in compounding the daily diet of the cows on trial. The selection among the various kinds of grain feed for the daily diet was, for obvious reasons, confined to but a few, — viz., corn meal or corn and cob meal, wheat bran and gluten meal (Chicago variety). (See Eighth Annual Report, pages 12–15.) These articles were at any time, in sufficient quantity and of good quality, at our disposal; they all enjoyed a fair reputation of fitness for milk production.

Having made ourselves, by actual trial, to a certain degree familiar with the comparative feeding effect and the special economical merits of the above-stated coarse fodder articles under specified conditions, *it was decided to institute a new series of feeding experiments with milch cows for the special purpose of studying the feeding effect and the general economy of some of our most prominent concentrated commercial feed stuffs, as old and new process linseed meal, cotton-seed meal and gluten meal, when fed in equal weights in place of each other and in connection with the same kinds of fine and coarse fodder articles.*

The results of one experiment, which was planned to ascertain the comparative merits of old and new process linseed meal as constituents of the daily diet of milch cows, under otherwise corresponding circumstances, has been already published in Bulletin 38, and in our last annual report, pages 15–24.

Three more recent experiments of a similar character, with Chicago gluten meal and old-process linseed meal, with Chicago gluten meal and cotton-seed meal, and with dried brewers' grain and wheat bran, are reported within a few subsequent pages, marked 1, 2, 3.

1. *Feeding Experiment with Milch Cows.*

Old-process linseed meal *vs.* gluten meal (Chicago variety), Oct. 21 to Dec. 31, 1889.

This feeding experiment was instituted as above intimated for the special purpose of comparing the effect of old-process linseed meal with that of gluten meal on the cost of feed and on the yield of milk, when fed in equal weights as substitutes of each other in connection with the same kinds and the same quantities of coarse and fine fodder articles. Six cows, grades, served in the trial; the observation lasted from ten to twelve weeks.

1. *History of Cows.*

NAME.	Breed.	Age (Years).	Last Calf dropped.	Daily Yield of Milk at beginning of Trial (Quarts).	Number of Months on Trial.
Juno, .	Grade Ayrshire, .	7	June 22, 1889,	11–12	2½
Flora, .	Grade Durham, .	6	Dec. 22, 1888,	9–10	2½
Eva, . .	Grade Jersey, .	10	Oct. 7, 1888,	7–8	2½
Elsie, .	Grade Holstein, .	7	Feb. 26, 1889,	7–8	2½
Jessie, .	Grade Jersey, .	6	Jan. 12, 1889,	8–9	2½
Annie, .	Grade Jersey, .	7	June 19, 1888,	8–9	2½

The cows thus far used in all our feeding experiments for the production of milk have been grades of more or less uncertain parentage. We secure them usually on the condition that they are new milch cows, from one to two weeks after calving when bought, and of fair milking quality, yielding from fifteen to sixteen quarts per day at this time. They serve usually in the trials until their daily yield of milk becomes unprofitable, from five to six quarts, when they are replaced by new milch cows.

2. *Description of Fodder Articles.*

The general character and chemical composition of the different fodder ingredients used in the preparation of the daily diet may be seen from the following statement: —

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Hay.
Moisture at 100° C., . .	11.67	9.27	9.80	9.88	9.72
Dry matter, ...	88.33	90.73	90.20	90.12	90.28
	100.00	100.00	100.00	100.00	100.00
Analyses of Dry Matter.					
Crude ash, ...	1.89	7.47	1.25	7.39	6.43
" cellulose, . . .	1.44	9.75	1.75	8.74	32.28
" fat, ...	4.44	5.48	7.00	7.24	2.49
" protein, . . .	10.46	17.53	31.25	36.97	9.54
Non-nitrogenous matter, .	81.77	59.77	58.75	39.66	49.26
	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents contained in the Various Fodder Articles used.

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Hay.
Moisture at 100° C., . .	11.67	9.27	9.80	9.88	9.72
Nitrogen, ...	1.479	2.545	4.510	5.331	1.379
Phosphoric acid, . . .	0.713	2.900	0.392	1.646	0.359
Potassium oxide, . . .	0.430	1.637	0.049	1.162	1.572

3. *Mode of Feeding.*

The daily fodder rations contained per head throughout the entire experiment three and one-fourth pounds of corn meal and three and one-fourth pounds of wheat bran, with either three and one-fourth pounds of gluten meal (Chicago variety) or three and one-fourth pounds of old-process linseed meal as grain feed ration. A fair quality of English hay, first cut of upland meadows, served as the sole coarse feed during the entire experiment. The daily ration of hay was controlled by the appetite of each cow engaged in the trial. It varied from eighteen to twenty-two pounds per head in case of different animals.

One-half the above-stated grain feed ration was fed with some hay at the time of milking in the morning and the other half in a similar way during milking in the evening. The remainder of the hay was given at noon and after milking in the evening. Water was offered twice daily, as a rule, one and one-half to two hours after feeding the grain feed.

The daily fodder rations described farther on represent the *average composition* of the daily diet per head during the different succeeding feeding periods. The calculation of the cost of the daily fodder rations below stated is based on the contemporary local market price of the various fodder articles used in their combination.

Local Market Cost of the Various Fodder Articles used from Oct. 21 to Dec. 31, 1889.

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Hay.
Per 2,000 pounds, . .	$19 00	$17 50	$23 00	$27 00	$15 00
Per pound (cents), . .	0.95	0.875	1.15	1.35	0.75

Commercial Value of the Essential Fertilizing Constituents contained in the Above Fodder Articles.

Nitrogen, 17 cents; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

Moisture at 100° C., . .	11.67	9.27	9.80	9.88	9.72
Nitrogen, ...	1.479	2.545	4.510	5.331	1.379
Phosphoric acid, . . .	.713	2.900	0.392	1.646	0.359
Potassium oxide, . . .	.430	1.637	0.049	1.162	1.572
Valuation per 2,000 pounds,	$6 27	$13 60	$15 85	$21 15	$6 53

Obtainable Manurial Value (per Ton), allowing a Loss of 20 Per Cent. contained in the Milk sold.

	$5 02	$10 88	$12 68	$16 92	$5 22

Net Cost of Above Fodder Articles per 2,000 Pounds (obtained by deducting the Obtainable 80 Per Cent. of Manurial Value from their Market Cost).

	$13 98	$6 62	$10 32	$10 08	$9 78

Net Cost per Pound (Cents).

	0.699	0.331	0.516	0.504	0.489

Average Composition of the Daily Fodder Rations used during Different Periods of the Experiment.

I. AND II.

Corn meal, ...	3.25	lbs.
Wheat bran, ...	3.25	"
Gluten meal, ...	3.25	"
Hay, ...	19.50	"
Total cost, ...	24.30	cts.
Net cost, ...	14.64	"
Manurial value obtainable, ...	9.66	"
Nutritive ratio, ...	1 : 6.35	

Average Composition, etc. — Concluded.

III.

Corn meal,	3.25 lbs.
Wheat bran,	3.25 "
Old-process linseed meal,	3.25 "
Hay,	18.50 "
Total cost,	24.18 cts.
Net cost,	14.06 "
Manurial value obtainable,	10.12 "
Nutritive ratio,	1:5.73

Summary of the Cost of the Daily Fodder Rations.

	PERIODS.		
	I.	II.	III.
	Cents.	Cents.	Cents.
Market cost,	24.30	24.30	24.18
Manurial value obtainable,	9.66	9.66	10.12
Net cost,	14.64	14.64	14.06

4. *Valuation of Feed.*

The commercial valuation of the feed stuffs used in the above-described fodder rations is based on their market price per ton of 2,000 pounds at Amherst during the time occupied by the experiment here under discussion, October, 1889, to January, 1890. The market cost of wheat bran, gluten meal and, in particular, of corn meal has since in an exceptional degree advanced, while that of old-process linseed meal and of English hay has remained materially the same. Accepting the above-stated market prices as well as the chemical analysis of the different fodder articles as the basis for our financial calculation we find that the market cost of the daily grain feed rations (periods I., II.), consisting of corn meal and wheat bran with gluten meal, three and one-fourth pounds each, amounts to 9.67 cents, while in case of a corresponding quantity of corn meal, wheat bran and old-process linseed meal it amounts to 10.32 cents, a difference of 0.63 cents in favor of the gluten meal containing daily grain feed ration.

Allowing on the other hand in our calculation the commercial value of 80 per cent. of the nitrogen, phosphoric acid and potassium oxide contained in the grain feed constituents of the different daily fodder rations as obtainable in form of the manurial refuse, we notice that the higher market price of the old-process linseed meal ($27 per ton) as compared with that of the gluten meal ($23 per ton), a difference of four dollars in favor of the latter, is practically offset by the higher commercial value of the manurial refuse obtained when feeding old-process linseed meal, pound for pound, in place of gluten meal in connection with an otherwise corresponding daily diet of milch cows. The net cost of the gluten meal containing daily grain feed ration (periods I., II.) amounts per head to 5.03 cents, while that of the old-process linseed meal containing grain feed portion of the daily fodder rations (period III.) amounts to 4.99 cents, a difference of 0.04 cents in favor of the latter, too small an amount to deserve serious consideration from a commercial stand-point.

Average Quantity of Milk per Day (*Quarts*).

[1 quart = 2.15 pounds.]

FEEDING PERIODS.	Juno.	Flora.	Eva.	Elsie.	Jessie.	Annie.
I.,	11.63	9.87	7.37	7.70	8.37	8.06
II.,	11.27	9.11	7.14	7.42	8.23	7.55
III.,	9.67	8.64	6.28	7.07	7.87	6.90
Average,	10.85	9.21	7.27	7.39	8.16	7.50

An examination of the above-stated average daily yield of milk in case of different cows shows a gradual decline from period to period. The decline in the daily yield of milk of the second period, as compared with that of the first period, varies in case of different cows from .14 to .76 quarts and averages per head 0.4 quarts for the entire herd. The difference in the decline of the daily yield of milk, when substituting pound for pound old-process linseed meal for gluten meal in the daily diet (period III.), is as a rule more marked and less uniform, as far as different animals are concerned, than will be noticed when comparing first and second feeding periods in the stated direction. The actual decline in average daily yield of milk when passing from II. into III. period varies in case of different cows from .35 to 1.6 quarts, and amounts to .71 quarts per head in case of the entire herd.

	I.*	II.†
Juno,	11.63 — 9.67	10.85
Flora,	9.87 — 8.64	9.21
Eva,	7.39 — 6.28	6.93
Elsie,	7.70 — 7.07	7.39
Jessie,	8.37 — 7.87	8.15
Annie,	8.06 — 6.90	7.50

* Variations in daily production of milk during the entire feeding experiment (quarts).

† Average quantity of milk per day for the entire feeding experiment (quarts).

Analyses of Milk (Per Cent.).

Juno.

	Oct. 15.	Dec. 4.	Dec. 17.	Dec. 24.	Dec. 31.
Solids,	13.22	13.16	12.61	12.25	13.68
Fat,	4.03	3.56	3.75	3.62	4.33
Solids not fat,	9.19	9.60	8.86	8.63	9.35

Flora.

	Oct. 15.	Dec. 4.	Dec. 17.	Dec. 24.	Dec. 31.
Solids,	13.35	14.04	13.68	13.38	13.36
Fat,	4.10	4.18	3.92	3.92	3.33
Solids not fat,	9.25	9.86	9.76	9.46	10.03

Eva.

	Oct. 15.	Dec. 4.	Dec. 17.	Dec. 24.	Dec. 31.
Solids,	16.25	16.88	17.65	16.70	16.92
Fat,	6.10	6.18	6.18	6.18	6.15
Solids not fat,	10.15	10.70	11.47	10.52	10.77

Analyses of Milk (*Per Cent.*) — Concluded.

Elsie.

	Oct. 15.	Dec. 4.	Dec. 17.	Dec. 24.	Dec. 31.
Solids,	12.82	13.42	12.55	12.80	13.00
Fat,	3.55	3.92	3.65	4.08	4.00
Solids not fat,	9.27	9.32	8.90	8.72	9.00

Jessie.

	Oct. 15.	Dec. 4.	Dec. 17.	Dec. 24.	Dec. 31.
Solids,	14.74	14.96	15.08	14.96	14.12
Fat,	5.33	5.46	5.40	5.32	4.90
Solids not fat,	9.41	9.50	9.68	9.64	9.22

Annie.

	Oct. 15.	Dec. 4.	Dec. 17.	Dec. 24.	Dec. 31.
Solids,	15.68	15.44	14.80	13.68	14.88
Fat,	5.18	5.24	5.29	3.77	5.11
Solids not fat,	10.50	10.20	9.51	9.91	9.77

Live Weight of Animals during the Feeding Periods (*Pounds*).

FEEDING PERIODS.	NAME OF COW.					
	Juno.	Flora.	Eva.	Elsie.	Jessie.	Annie.
I,	1,064	980	1,086	1,200	868	954
II.,	1,089	992	1,098	1,207	880	969
III.,	1,070	1,000	1,092	1,220	888	981
Gain at close,	6	20	6	20	20	27

Conclusions. — The previously stated results of our inquiry into the comparative merits of gluten meal (Chicago variety) and of old-process linseed meal as constituents of the daily diet of milch cows lead us to the following conclusions: 1. The substitution of three and one-fourth pounds of gluten meal (Chicago variety) by the same weight of old-process linseed meal at stated local market prices, and under otherwise corresponding circumstances, raises the market cost of the daily fodder ration per head 0.65 cents. Taking in both instances the obtainable manurial value (80 per cent.) into consideration, the old-process linseed meal proves, in our case, 0.04 cents cheaper than gluten meal. The higher manurial value of the old-process linseed meal as compared with our sample of gluten meal fairly equals the difference in the local market cost of both articles. 2. The Chicago gluten meal leads in our case the old-process linseed meal in every instance, as far as the nutritive effect of both is concerned. The difference is not great, yet worthy of special notice under stated market conditions. 3. The quality of the milk as far as its density is concerned shows no marked difference during the entire experiment.

FEEDING RECORD.

1. *Juno.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.					Amount of Dry Vegetable Matter in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Hay.					
1889.										
Oct. 21 to Nov. 10, ...	3.25	3.25	3.25	–	21.90	28.52	11.63	2.45	1:6.51	1,064
Nov. 13 to Dec. 3, ...	3.25	3.25	3.25	–	21.81	28.42	11.27	2.52	1:6.51	1,089
Dec. 11 to Dec. 31, ...	3.25	3.25	–	3.25	18.95	25.84	9.67	2.67	1:5.76	1,070
2. *Flora.*										
Oct. 21 to Nov. 10, ...	3.25	3.25	3.25	–	17.90	24.91	9.87	2.52	1:6.25	980
Nov. 13 to Dec. 3, ...	3.25	3.25	3.25	–	18.86	25.78	9.11	2.83	1:6.31	992
Dec. 11 to Dec. 31, ...	3.25	3.25	–	3.25	19.43	26.27	8.64	3.04	1:5.79	1,000
3. *Eva.*										
Oct. 21 to Nov. 10, ...	3.25	3.25	3.25	–	18.86	25.78	7.39	3.49	1:6.31	1,086
Nov. 13 to Dec. 3, ...	3.25	3.25	3.25	–	19.71	26.54	7.14	3.72	1:6.37	1,098
Dec. 11 to Dec. 31, ...	3.25	3.25	–	3.25	18.19	25.15	6.28	4.00	1:5.70	1,092

4. Elsie.

Oct. 21 to Nov. 10, ...	3.25	3.25	3.25	–	19.33	25.83	7.70	3.35	1:6.34	1,200
Nov. 13 to Dec. 3, ...	3.25	3.25	3.25	–	18.95	25.86	7.42	3.49	1:6.32	1,207
Dec. 11 to Dec. 31, ...	3.25	3.25	–	3.25	17.93	24.92	7.07	3.52	1:5.68	1,220

5. Jessie.

Oct 21 to Nov. 10, ...	3.25	3.25	3.25	–	19.43	26.28	8.37	3.14	1:6.35	868
Nov. 13 to Dec. 3, ...	3.25	3.25	3.25	–	19.62	26.45	8.23	3.21	1:6.36	880
Dec. 11 to Dec. 31, ...	3.25	3.25	–	3.25	18.40	25.37	7.87	3.22	1:5.72	888

6. Annie.

Oct. 21 to Nov. 10, ...	3.25	3.25	3.25	–	17.62	24.65	8.06	3.06	1:6.24	954
Nov. 13 to Dec. 3, ...	3.25	3.25	3.25	–	17.95	24.95	7.55	3.30	1:6.25	969
Dec. 11 to Dec. 31, ...	3.25	3.25	–	3.25	17.69	24.70	6.90	3.58	1:5.66	981

Total Cost of Feed per Quart of Milk.

Juno.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed.	Total Amount of Gluten Meal consumed.	Total Amount of Old-process Linseed Meal consumed.	Total Amount of Wheat Bran consumed.	Total Amount of Hay consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents)
1889.									
Oct. 21 to Nov. 10, ...	244.19	11.63	68.25	68.25	–	68.25	460.00	$5 48	2.24
Nov. 13 to Dec. 3, ...	236.74	11.27	68.25	68.25	–	68.25	458.00	5 47	2.31
Dec. 11 to Dec. 31, ...	203.02	9.67	68.25	–	68.25	68.25	398.00	5 16	2.54

Flora.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed.	Total Amount of Gluten Meal consumed.	Total Amount of Old-process Linseed Meal consumed.	Total Amount of Wheat Bran consumed.	Total Amount of Hay consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents)
Oct. 21 to Nov. 10, ...	207.21	9.87	68.25	68.25	–	68.25	376.00	$4 85	2.34
Nov. 13 to Dec. 3, ...	191.28	9.11	68.25	68.25	–	68.25	396.00	5 00	2.61
Dec. 11 to Dec. 31, ...	181.50	8.64	68.25	–	68.25	68.25	408.00	5 23	2.88

Eva.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed.	Total Amount of Gluten Meal consumed.	Total Amount of Old-process Linseed Meal consumed.	Total Amount of Wheat Bran consumed.	Total Amount of Hay consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents)
Oct. 21 to Nov. 10, ...	155.23	7.39	68.25	68.25	–	68.25	396.00	$5 00	3.22
Nov. 13 to Dec. 3, ...	149.88	7.14	68.25	68.25	–	68.25	414.00	5 14	3.43
Dec. 11 to Dec. 31, ...	131.86	6.28	68.25	–	68.25	68.25	382.00	5 04	3.82

			Elsie.						
Oct. 21 to Nov. 10,	161.63	7.70	68.25	68.25	-	68.25	406.00	$5 08	3.14
Nov. 13 to Dec. 3,	155.81	7.42	68.25	68.25	-	68.25	398.00	5 02	3.22
Dec. 11 to Dec. 31,	148.49	7.07	68.25	-	68.25	68.25	376.50	4 99	3.36
			Jessie.						
Oct. 21 to Nov. 10,	175.81	8.37	68.25	68.25	-	68.25	408.00	$5 09	2.90
Nov. 13 to Dec. 3,	172.91	8.23	68.25	68.25	-	68.25	412.00	5 12	2.96
Dec. 11 to Dec. 31,	165.35	7.87	68.25	68.25	68.25	-	386.50	5 07	3.08
			Annie.						
Oct. 21 to Nov. 10,	169.30	8.06	68.25	68.25	-	68.25	370.00	$4 81	2.84
Nov. 13 to Dec. 3,	158.60	7.55	68.25	68.25	-	68.25	374.00	4 84	3.05
Dec. 11 to Dec. 31,	145.00	6.90	68.25	68.25	68.25	-	371.50	4 96	3.42

NET COST OF MILK AND MANURIAL VALUE OF FEED.

Juno.

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1889.					Cents.	Pounds.
Oct. 21 to Nov. 10, .	$5 48	$2 72	$2 18	$3 30	1.35	1,085
Nov. 13 to Dec. 3, .	5 47	2 71	2 17	3 30	1.39	1,095
Dec. 11 to Dec. 31, .	5 16	2 69	2 15	3 01	1.48	1,034
Flora.						
Oct. 21 to Nov. 10, .	$4 85	$2 45	$1 96	$2 89	1.39	980
Nov. 13 to Dec. 3, .	5 00	2 51	2 01	2 99	1.56	990
Dec. 11 to Dec. 31, .	5 23	2 72	2 18	3 05	1.68	1,015
Eva.						
Oct. 21 to Nov. 10, .	$5 00	$2 51	$2 01	$2 99	1.93	1,085
Nov. 13 to Dec. 3, .	5 14	2 57	2 06	3 08	2.05	1,118
Dec. 11 to Dec. 31, .	5 04	2 63	2 10	2 94	2.23	1,098
Elsie.						
Oct. 21 to Nov. 10, .	$5 08	$2 50	$2 00	$3 08	1.85	1,200
Nov. 13 to Dec. 3, .	5 02	2 52	2 02	3 00	1.93	1,200
Dec. 11 to Dec 31, .	4 99	2 62	2 10	2 89	1.95	1,220
Jessie.						
Oct. 21 to Nov. 10, .	$5 09	$2 51	$2 01	$3 08	1.75	865
Nov. 13 to Dec. 3, .	5 12	2 53	2 02	3 10	1.79	880
Dec. 11 to Dec. 31, .	5 07	2 65	2 12	2 95	1.79	875
Annie.						
Oct. 21 to Nov. 10, .	$4 81	$2 39	$1 91	$2 90	1.71	965
Nov. 13 to Dec 3, .	4 84	2 40	1 92	2 92	1.84	980
Dec. 11 to Dec 31, .	4 96	2 61	2 09	2 87	1.98	983

Analyses of Fodder Articles used in the Experiment.

Corn Meal (Average).

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	11.67	233.40	–	–	1 : 9.65
Dry matter,	88.33	1,766.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,					
" cellulose,	1.89	37.80	–	–	
" fat,	1.44	28.80	9.79	34	
" protein (nitrogenous	4.44	88.80	67.49	76	
matter),	10.46	209.20	177.82	85	
Non-nitrogenous extract matter,	81.77	1,635.40	1,537.28	94	
	100.00	2,000.00	1,792.38	–	

Gluten Meal.

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.80	186.00	–	–	1 : 2.60
Dry matter,	90.20	1,804.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.25	25.00	–	–	
" cellulose,	1.75	35.00	11.90	34	
" fat,	7.00	140.00	106.40	76	
" protein (nitrogenous matter),	31.25	625.00	531.25	85	
Non-nitrogenous extract matter,	58.75	1,175.00	1,104.50	94	
	100.00	2,000.00	1,754.05	–	

Old-process Linseed Meal (Average).

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	9.88	197.60	–	–	1 : 1.70
Dry matter, ...	90.12	1,802.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	7.39	147.80	–	–	
" cellulose, . . .	8.74	174.80	45.45	26	
" fat, ...	7.24	144.80	131.77	91	
" protein (nitrogenous matter), . .	36.97	739.40	643.28	87	
Non-nitrogenous extract matter, ...	39.66	793.20	721.81	91	
	100.00	2,000.00	1,542.31	–	

Hay (Average).

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	9.72	194.40	–	–	1 : 9.68
Dry matter, . . .	90.28	1,805.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	6.43	128.60	–	–	
" cellulose, . . .	32.28	645.60	374.45	58	
" fat, ...	2.49	49.80	22.91	46	
" protein (nitrogenous matter), . .	9.54	190.80	108.76	57	
Non-nitrogenous extract matter, ...	49.26	985.20	620.68	63	
	100.00	2,000.00	126.80	–	

2. *Feeding Experiment with Milch Cows.*

Gluten meal (Chicago variety) *vs.* cotton-seed meal and old-process linseed meal, November, 1890, to June 1891.

Below are briefly recorded the results of observations with cotton-seed meal and old-process linseed meal when fed as substitutes for gluten meal (Chicago variety) in an otherwise corresponding daily diet of milch cows. The experiment was instituted, as has been intimated above, mainly for the purpose of comparing the effect of cotton-seed meal and old-process linseed meal with that of gluten meal (Chicago variety) on the cost of the feed consumed and on the quantity and the quality of the milk produced, when fed each in equal weight as an ingredient of an otherwise corresponding daily diet of milch cows.

1. *History of Cows.*

Nine cows, grades of various descriptions and of different milking periods, served in the trial.

NAME OF COW.	Breed.	Age (Years).	Last Calf dropped.	Daily Yield of Milk at beginning of Trial (Quarts).	Number of Months on Trial.
1. Jessie, . .	Grade Jersey, .	7	Jan. 12, 1889,	6–7	5–6
2. Pearl, . .	Native, . .	6	Aug. 8, 1890,	10–11	7
3. Pink, . .	Native, . .	7	Jan. 23, 1890,	7–8	7
4. Roxy, . .	Grade Ayrshire,	7	Feb. 5, 1890,	6–7	2½
5. Buttercup, .	Grade Ayrshire,	5	Jan. 2, 1891,	13–14	4
6. Nancy, .	Native, . .	8	March 16, 1890,	8–9	4
7. Clarissa, .	Grade Durham,	7	March 18, 1891,	9–10	2
8. Juno, . .	Grade Ayrshire,	7	June 22, 1889,	7–8	3
9. Favorite, .	Grade Durham,	6	Feb. 20, 1891,	11–12	3

2. *Description of Fodder Articles.*

The daily fodder rations contained per head throughout the entire experiment, as fine or grain feed, three pounds of corn meal and three pounds of wheat bran; to these were added for stated reasons at different stages of the observation, per head, either three pounds of gluten meal, or three pounds of old-process linseed meal, or three pounds of cotton-seed meal to complete the daily ration of grain or fine feed.

The general character of the various kinds of grain feed used in the daily diet may be seen from the following analyses of the different articles of grain feed used : —

	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.
Moisture at 100° C., . .	13.26	12.11	9.77	8.72	10.90
Dry matter, ...	86.74	87.89	90.23	91.28	89.10
	100.00	100.00	100.00	100.00	100.00
Analyses of Dry Matter.					
Crude ash, ...	1.72	7.40	8.18	5.96	1.02
" cellulose, . .	2.28	12.17	7.74	8.23	1.28
" fat, ...	4.90	5.04	11.33	9.87	7.36
" protein, . . .	12.94	18.48	44.41	36.19	34.79
Non-nitrogenous matter, .	78.16	56.91	28.34	39.75	55.55
	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents of the Above Fodder Articles.

Nitrogen, 15 cents per pound; phosphoric acid, 5½ cents; potassium oxide, 4½ cents.

	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.
Moisture, ...	13.26	12.11	9.77	8.72	10.90
Nitrogen, ...	1.796	2.599	6.412	5.285	4.959
Phosphoric acid, . .	.707	2.845	2.333	1.780	.425
Potassium oxide, . .	.435	1.625	1.723	1.214	.045
Valuation per 2,000 pounds,	$6 56	$12 39	$23 36	$18 90	$15 38

The coarse feed used in compounding the daily diet in this connection consisted either of nothing but rowen, — hay of second cut of upland meadows, — or of rowen and a mixed ensilage, consisting of equal weights of green fodder corn and of green soja bean, or of nothing but corn stover. The same variety of dent corn, "Pride of the North," furnished the green fodder corn for the mixed ensilage and for the corn stover. The corn stover was obtained from the fully matured corn, while the corn used for the mixed ensilage had reached the stage of growth when the kernels begin to glaze.

The soja bean when used for ensilage had finished its growth and showed a liberal formation of seed pods. In both instances the entire plant was cut a few inches above ground.

The corn, — stalks, ears and leaves, — was reduced to pieces of from one to one and one-half inches in length, and the soja bean, — entire plant, — being still soft and succulent in the stated period of growth, was merely cut into two or three pieces. Both plants thus prepared were subsequently filled alternately, in layers one foot in thickness, into a silo. The filling of the silo was carried on as fast as the material could be conveniently secured. Each layer was carefully packed down and the whole finally covered with layers of tar paper and matched boards. The latter were held in place by barrels filled with sand. The silo was filled at the beginning of September, 1890, and opened for use during the succeeding January.

The mixed ensilage thus produced was of a yellowish green color, and less acid than a clear corn ensilage obtained from the same lot of fodder corn treated in the same manner and at the same time in an adjoining silo. The influence which in our case an addition of an equal weight of a nearly matured soja bean exerts on the composition of corn ensilage will be seen from a comparison of the following analyses of the two kinds of ensilage, No. 1 and No. 2.

The clear corn ensilage, No. 1, was obtained from the same lot of fodder corn which served for the production of the above-described mixed ensilage, No. 2. The silos were in both cases filled in the same way, and as far as practicable at the same time. They were of a corresponding size and contained fairly even quantities of vegetable matter. Both were opened for general use at about the same time, four months after filling. The samples that served for the analyses represent in each case the average of the ensilage obtained by cutting in a vertical direction through the contents of each silo.

Analyses of Dry Matter.

	No. 1. Corn Ensilage.	No. 2. Corn and Soja Bean Ensilage.
	Per Cent.	Per Cent.
Crude ash,	6.73	11.04
" cellulose,	26.90	27.84
" fat,	3.27	5.35
" protein,	8.97	15.27
Non-nitrogenous matter,	54.13	40.50
	100.00	100.00

The composition of the dry vegetable matter of the mixed ensilage, No. 2, compares well with that of a medium quality of red clover hay.

The successful cultivation of the soja bean upon the fields of the Massachusetts State Agricultural Experiment Station has been repeatedly pointed out in previous annual reports. The superior feeding effect of green soja bean as a coarse fodder constituent in the diet of milch cows has been shown in our summer feeding experiments of 1890. (See Eighth Annual Report, pages 39 to 54.) Our experience this year confirms our previous statement. The high economical value of this reputed fodder crop finds again a striking illustration in the experiment reported in detail upon some succeeding pages.

The general character of the different coarse fodder articles used on this occasion will be seen from the subsequent statement.

Fodder Analyses of the Different Coarse Fodder Articles used.	Rowen.	Corn and Soja Bean Ensilage.	Corn Stover.
Moisture at 100° C.,	13.90	71.03	19.89
Dry matter,	86.10	28.97	80.11
	100.00	100.00	100.00
Analyses of Dry Matter.	8.28	11.04	6.33
Crude ash,	28.88	27.84	34.59
" cellulose,	3.91	5.35	1.28
" fat,	13.45	15.27	5.74
" protein,	45.48	40.50	52.06
Non-nitrogenous extract matter,			
	100.00	100.00	100.00

Fertilizing Constituents.

Nitrogen, 15 cents per pound; phosphoric acid, 5½ cents; potassium oxide, 4½ cents.

MANURIAL CONSTITUENTS IN THE ABOVE-STATED COARSE FEED STUFFS.	Rowen.	Corn and Soja Bean Ensilage.	Corn Stover.
Moisture,	13.90	71.03	19.89
Nitrogen,	1.853	.708	.735
Phosphoric acid,	.464	.420	.259
Potassium oxide,	1.966	.444	1.235
Valuation per 2,000 pounds,	$7 84	$2 98	$3 60

3. *Mode of Feeding.*

The daily grain feed ration contained per head throughout the entire experiment three pounds of corn meal and three pounds of wheat bran. To these were added, per head, at different stages of our observation, either three pounds of gluten meal, or three pounds of old-process linseed meal, or three pounds of cotton-seed meal, to complete the grain feed part of the daily diet. One-half of the grain feed was fed with some of the coarse feed at the time of milking in the morning and the other half in a similar way during milking in the evening. The remainder of the coarse fodder was given at noon and after milking in the evening.

The consumption of the coarse fodder constituents of daily diet, as far as quantity is concerned, was in most instances controlled by the appetite of each animal. To satisfy the latter, a small excess was offered and the remaining portion subsequently weighed back. This practice was adopted, in particular, in case of rowen when fed alone as coarse feed, and in case of mixed ensilage and of corn stover. Five pounds of rowen, however, were always fed per day to each cow whenever the mixed ensilage of corn and soja bean formed a prominent part of their daily diet. The daily fodder rations, which are described below in detail, represent the *average composition* of the daily diet used, per head, during the different succeeding feeding periods.

The subsequent record of the cost of the different fodder ingredients used in the daily fodder ration can assist in recognizing the basis for our calculations of the cost of the latter.

Local Market Cost of the Various Fodder Articles used from November, 1890, to June, 1891.

	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn and Soja Bean Ensilage.	Corn Stover.
Per 2,000 pounds,	$28 00	$25 00	$28 00	$26 00	$28 00	$15 00	$3 50	$5 00
Per pound (cents),	1.4	1.25	1.4	1.3	1.4	0.75	0.175	0.25

Commercial Value of the Essential Fertilizing Constitutents of the Above Fodder Articles.

Nitrogen, 15 cents; phosphoric acid, 5½ cents; potassium oxide, 4½ cents per pound.

Moisture,	13.26	12.11	9.77	8.72	10.90	13.90	71.03	19.89
Nitrogen,	1.796	2.599	6.412	5.285	4.959	1.853	.708	.735
Phosphoric acid,	.707	2.845	2.333	1.780	.425	.464	.420	.259
Potassium oxide,	.435	1.625	1.723	1.214	.045	1.966	.444	1.235
Valuation per 2,000 pounds,	$6 56	$12 39	$23 36	$18 90	$15 38	$7 84	$2 98	$3 60

Obtainable Manurial Value (per Ton), allowing a Loss of 20 Per Cent. contained in the Milk sold.

	$5 25	$9 91	$18 69	$15 12	$12 30	$6 27	$2 38	$2 88

Net Cost of Above Fodder Articles per 2,000 Pounds (obtained by deducting the Obtainable 80 Per Cent. of Manurial Value from their Market Cost).

	$22 75	$15 09	$9 31	$10 88	$15 70	$8 73	$1 12	$2 12

Net Cost per Pound (Cents).

	1.14	0.75	0.465	0.54	0.78	0.44	0.056	0.106

Average Composition of the Principal Daily Fodder Rations used at Different Periods of the Experiment.

I.		II.	
Corn meal (pounds),	3.00	Corn meal (pounds),	3.00
Wheat bran,	3.00	Wheat bran,	3.00
Cotton-seed meal,	3.00	Gluten meal,	3.00
Rowen,	20.00	Rowen,	17.50
Total cost (cents),	27.15	Total cost (cents),	25.28
Net cost,	15.81	Net cost,	15.68
Manurial value obtainable,	11.34	Manurial value obtainable,	9.60
Nutritive ratio,	1 : 4.60	Nutritive ratio,	1 : 5.13

Average Composition, etc. — Concluded.

III.		IV.	
Corn meal (pounds),	3.00	Corn meal (pounds),	3.00
Wheat bran,	3.00	Wheat bran,	3.00
Old-process linseed meal,	3.00	Cotton-seed meal,	3.00
Rowen,	17.40	Rowen,	5.00
Total cost (cents),	24.90	Corn and soja bean ensilage,	42.15
Net cost,	14.91	Total cost (cents),	23.28
Manurial value obtainable,	9.99	Net cost,	11.62
Nutritive ratio,	1:4.83	Manurial value obtainable,	11.66
		Nutritive ratio,	1:4.17

V.		VI.	
Corn meal (pounds),	3.00	Corn meal (pounds),	3.00
Wheat bran,	3.00	Wheat bran,	3.00
Gluten meal,	3.00	Gluten meal,	3.00
Rowen,	5.00	Corn stover,	13.90
Corn and soja bean ensilage,	46.15	Total cost (cents),	15.63
Total cost (cents),	23.98	Net cost,	9.52
Net cost,	12.80	Manurial value obtainable,	6.11
Manurial value obtainable,	11.18	Nutritive ratio,	1:6.74
Nutritive ratio,	1:4.70		

VII.		VIII.	
Corn meal (pounds),	3.00	Corn meal (pounds),	3.00
Wheat bran,	3.00	Wheat bran,	3.00
Cotton-seed meal,	3.00	Cotton-seed meal,	3.00
Corn stover,	14.00	Rowen,	17.60
Total cost (cents),	15.65	Total cost (cents),	25.35
Net cost,	8.57	Net cost,	14.77
Manurial value obtainable,	7.08	Manurial value obtainable,	10.58
Nutritive ratio,	1:5.66	Nutritive ratio,	1:4.49

IX.	
Corn meal (pounds),	3.00
Wheat bran,	3.00
Gluten meal,	3.00
Rowen,	17.40
Total cost (cents),	25.20
Net cost,	15.63
Manurial value obtainable,	9.57
Nutritive ratio,	1:5.12

Summary of the Cost of the Daily Fodder Rations (Cents).

	PERIODS.								
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Market cost,	27.15	25.28	24.90	23.28	23.98	15.63	15.65	25.35	25.20
Manurial value obtainable,	11.34	9.60	9.99	11.66	11.18	6.11	7.08	10.58	9.57
Net cost,	15.81	15.68	14.91	11.62	12.80	9.52	8.57	14.77	15.63

4. *On Valuation of Feed.*

The commercial valuation of the feed adopted in this report is based on the contemporary local market cost (November, 1890, to May, 1891) of the different fodder articles used, *i. e.*, their retail selling price at Amherst per ton. The market price of the coarse fodder constituents of the daily diet, as rowen, fodder corn, corn ensilage, soja beans and corn stover, is the same as during the preceding year for the same period, November, 1889, to May, 1890, while that of most of the grain feed constituents of the daily diet, as corn meal, wheat bran, gluten meal and cotton-seed meal, is exceptionally high as compared with that during the preceding year for corresponding months. Old-process linseed meal alone had suffered a slight reduction, one dollar per ton.

The changes in their market price were as follows: —

Local Market Price per Ton of 2,000 Pounds at Amherst, Mass.

	November, 1889, to June, 1890.	November, 1890, to June, 1891.
Corn meal,	$19 00	$28 00
Wheat bran,	17 50	25 00
Cotton-seed meal,	26 00	28 00
Old-process linseed meal,	27 00	26 00
Gluten meal (Chicago),	24 50	28 00
Rowen,	15 00	15 00
Corn and soja bean ensilage,	3 50	3 50
Corn stover,	5 00	5 00

The above-stated change in the market cost of corn meal, wheat bran, gluten meal and cotton-seed meal affects very materially the cost of the daily diet as compared with that of the preceding year. The daily *grain feed rations* which contain gluten meal as an ingredient (II., V., VI., IX.) are 3.32 cents higher than they would have been during the preceding year for the corresponding months; those which contain cotton-seed meal (I., IV., VII., VIII.) are 2.85 cents higher, and that which contains old-process linseed meal (III.) is 2.40 cents higher. This increase in cost is largely due to the exceptional high price of corn meal and wheat bran.

The substitution of gluten meal or of cotton-seed meal by old-process linseed meal, three pounds in each case, causes a reduction of but 0.3 cents in the market cost of the grain feed portion of the daily diet per head. *The market cost of the daily grain feed rations used per head during the entire experiment varies only from 11.85 cents to 12.15 cents, a difference of 0.3 cents.* Allowing, however, a proper recognition of the commercial value of the essential manurial substances, nitrogen, phosphoric acid and potassium oxide, contained in each of the grain feed constituents of the daily fodder rations, *we find in our case that the net cost of the cotton-seed meal containing daily grain feed rations (I.) amounts to 7.07 cents, while that of the old-process linseed meal containing daily grain feed rations (II.) is 7.29 cents, and that of gluten meal containing fine feed rations (III.) is 8.01 cents, a difference respectively of 0.22 to 0.94 cents per head.* This difference in net cost is due to the higher manurial value of cotton-seed meal and of old-process linseed meal as compared with gluten meal at stated market prices.

The choice of different coarse fodder articles in the daily diet exerts a much greater influence on the market cost of the latter than that of the different kinds of grain feed. The market cost of the coarse fodder portion of the daily diet averages 13.5 cents in case rowen alone (eighteen pounds) serves as coarse feed; it averages 11.5 cents in case forty-four pounds of mixed ensilage and five pounds of rowen are daily fed; and it amounts to from 4 to 4½ cents in case from sixteen to eighteen pounds of corn stover are used per day for that purpose. These facts find their expression in the above-stated market cost of the nine complete daily fodder rations used during the trial. The market cost of the complete daily fodder rations I., II., III., VIII., IX., containing rowen, averages 25.55 cents; rations IV., V., containing mixed ensilage with rowen, average 23.63 cents; and rations VI., VII., containing corn stover as coarse feed, average 15.64 cents. *The difference in the market cost of the above-described nine daily fodder rations, caused by the use of different coarse fodder constituents, rises in some instances as high as 9.91 cents.* This sum, it will be noticed, is three times as large as the difference due to an exceptional rise in the market cost of the grain feed portion of the various daily fodder rations used, accepting the ruling local market prices of feed stuff at the close of 1889 and of 1890 as the basis of our valuation.

Taking the manurial value of the different coarse fodder constituents used into consideration, we find the difference of their *net cost* not less striking than has been shown above to be the case in regard to their *market cost.*

	Market Cost.	Net Cost.	Manurial Value.
	Cents.	Cents.	Cents.
Rowen, 18 pounds, ...	13.5	7.92	5.57
Mixed ensilage, 44 pounds, rowen, 5 pounds, ...	11.45	4.66	6.79
Corn stover, 18 pounds, . . .	4.50	1.91	2.59

The high market price of two of our most prominent home-raised coarse fodder articles, first and second cut of upland meadow, — English hay and rowen, — affects seriously the degree of our financial results in the production of milk, as far as the cost of feed is concerned. We are in need of a cheaper source of supply of coarse fodder substances than a considerable proportion of our grass lands, pastures and meadows in their present state of productiveness can claim to give. More satisfactory results can be obtained, no doubt, in many cases by turning indifferently yielding dry grass lands, if at all capable of higher cultivation, to account for the production of some other suitable fodder crop than grasses. The good services of dry fodder corn, corn stover and a good corn ensilage, for a more economical production of milk, are deservedly from day to day more generally recognized. However gratifying this fact may be considered, it is not advisable, in the light of past experience, in a general farm management to raise one fodder crop at the exclusion of all others, however lucrative at the time this practice may prove; such a course can at best only offer a temporary relief. The introduction of a greater variety, in particular, of annual reputed fodder-crops promises a more permanent improvement in fodder supply. Such a course, wherever adopted, has not only resulted in cheapening the production of milk and beef, but has proved to be a most economical way to raise the general productiveness of farm lands to a higher standard.

Our local experience with a variety of annual leguminous fodder crops, as vetches, serradella and soja bean, has been very encouraging. The satisfactory results obtained in previous years are fully confirmed during the present season, when a mixed crop of vetch and oats and soja bean has served as the principal coarse fodder for milk production from the middle of June to the beginning of September.

5. *Average Quantity of Milk per Day* (*Quarts*).

	FEEDING PERIODS.								
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
1. Jessie, . . .	6.77	5.30	5.70	7.54	8.47	6.80	5.50	–	–
2. Pearl, . . .	10.74	10.28	10.84	–	12.19	9.07	7.34	9.19	9.24
3. Pink, . . .	7.55	7.42	–	8.07	8.30	7.05	6.56	7.48	7.63
4. Roxy, . . .	6.87	5.64	5.25	–	–	–	–	–	–
5. Buttercup, . .	–	–	–	13.36	13.31	10.66	9.31	9.45	8.68
6. Nancy, . . .	8.34	7.68	7.49	8.31	8.54	–	–	–	–
7. Clarissa, . . .	–	–	–	–	–	–	9.47	10.04	11.37
8. Juno, . . .	7.29	6.70	6.45	7.50	–	–	–	–	–
9. Favorite, . . .	–	–	–	–	–	11.33	7.89	10.05	9.60

An examination of the above statements concerning the daily average yield of milk of the different cows on trial during the different feeding periods shows, almost without exception, that *our changes in the coarse fodder constituents of the daily diet have affected the results more seriously than our changes in the grain feed portion.* Among the coarse feed constituents used, ranks first mixed ensilage and rowen (periods IV., V.), then rowen (I., II., III., VIII., IX.) and dry corn stover last (VI., VII.), as far as the daily yield of milk is concerned.

The difference noticeable in the daily average yield of milk in case of rowen, as compared with corn stover, does in no instance deprive the latter of the claim to be the cheaper coarse fodder article of the two in our trial. Mixed ensilage, with rowen in place of corn stover, on the other hand, has raised in some instances the daily yield of milk more than three quarts (Pearl and Buttercup); allowing three cents per quart of milk makes the former the cheaper coarse fodder article of the two, under otherwise corresponding circumstances. These results are noticeable without reference to the particular combination of grain feed rations used in either case.

The influence of the various grain feed rations on the yield of milk in case of the same kind of coarse fodder ration is apparently, to a considerable degree, depending on the individual disposition of the animal on trial. Cotton-seed meal containing grain feed rations give in five out of six cases better results when fed with rowen than either gluten meal or old-process linseed meal ration, under otherwise corresponding conditions. Gluten meal and cotton-seed meal did equally well when fed with either mixed ensilage or corn stover. Old-process linseed meal has only been fed with rowen on the present occasion (I., II., III.); it compared well in yield of milk with gluten meal.

I. — Variations in daily production of milk during the entire feeding experiment (quarts).
II. — Average quantity of milk per day for the entire feeding experiment (quarts).

	I.	II.
Jessie, ...	5.30 — 8.48	6.58
Pearl, ...	7.34 — 12.19	9.86
Pink, ...	6.56 — 8.30	7.51
Roxy, ...	5.23 — 6.81	5.89
Buttercup, ...	8.69 — 13.36	10.80
Nancy, ...	7.49 — 8.54	8.07
Clarissa, ...	9.47 — 11.37	10.29
Juno, ...	6.45 — 7.50	6.99
Favorite, ...	7.89 — 11.33	9.72

Average Composition of Milk during Different Feeding Periods.

		1	2	3	4	5	6	7	8	9
PERIODS.		Jessie.	Pearl.	Pink.	Roxy.	Buttercup.	Nancy.	Clarissa.	Juno.	Favorite.
I., . .	Solids, per cent.,	15.62	12.62	15.37	14.79	-	13.13	-	13.91	-
	Fat, per cent., .	6.17	3.92	5.70	5.19	-	4.41	-	4.71	-
II., . .	Solids, per cent.,	17.85	12.77	14.73	15.18	-	13.33	-	13.82	-
	Fat, per cent., .	7.39	4.00	5.13	5.12	-	4.31	-	4.36	-
III., . .	Solids, per cent.,	17.69	13.50	-	15.31	-	14.47	-	14.30	-
	Fat, per cent., .	7.07	4.06	-	5.00	-	4.80	-	4.88	-
IV., . .	Solids, per cent.,	17.61	-	15.90	-	12.64	14.68	-	14.34	-
	Fat, per cent., .	7.09	-	6.00	-	3.65	5.00	-	4.96	-
V., . .	Solids, per cent.,	17.36	13.69	15.53	-	12.81	14.75	-	-	-
	Fat, per cent., .	7.02	4.27	5.74	-	3.79	5.00	-	-	-
VI., . .	Solids, per cent.,	17.02	13.94	15.86	-	12.64	-	-	-	13.09
	Fat, per cent., .	6.47	4.48	5.67	-	3.96	-	-	-	4.35
VII., . .	Solids, per cent.,	17.63	14.32	16.56	-	12.50	-	14.18	-	13.53
	Fat, per cent., .	7.26	5.04	6.09	-	4.05	-	5.01	-	4.58
VIII., .	Solids, per cent.,	-	13.74	15.82	-	12.98	-	14.18	-	12.78
	Fat, per cent., .	-	4.84	5.65	-	4.18	-	5.08	-	4.19
IX., . .	Solids, per cent.,	-	13.66	15.54	-	13.45	-	13.79	-	12.40
	Fat, per cent., .	-	4.04	5.43	-	4.27	-	4.60	-	3.48

Live Weight of Animals during the Feeding Periods (Pounds).

NAME.	FEEDING PERIODS.									Gain at Close.
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	
Jessie, ...	926	920	965	976	988	951	938	-	-	12
Pearl, ...	850	877	869	-	872	853	858	853	880	30
Pink, ...	910	932	-	914	948	947	952	956	973	63
Roxy, ...	1,010	1,016	992	-	-	-	-	-	-	—18
Buttercup, . .	-	-	-	781	797	795	785	766	775	—6
Nancy, ...	946	942	948	963	987	-	-	-	-	41
Clarissa, ...	-	-	-	-	-	-	833	856	848	15
Juno, ...	1,142	1,124	1,135	1,114	-	-	-	-	-	—28
Favorite, ...	-	-	-	-	-	826	775	809	801	—25

Conclusions. — A careful examination of the previously recorded results of our inquiry into the respective particular claims of cotton-seed meal, old-process linseed meal and gluten meal as constituents of the daily diet of milch cows, leads us to the following statements: —

1. The substitution of three pounds of gluten meal by either three pounds of cotton-seed meal or three pounds of old-process linseed meal, at stated market prices, and under otherwise corresponding circumstances, does not materially effect the *market cost* of the daily fodder ration used in our case. The difference in their market price amounts to 0.3 cents in favor of old-process linseed meal. Taking the obtainable manurial value into consideration, as far as the three stated grain feed constituents of the daily diet are concerned, three pounds of cotton-seed meal are 0.94 cents cheaper than three pounds of gluten meal and 0.22 cents cheaper than three pounds of old-process linseed meal.

2. The comparative nutritive effect of cotton-seed meal, gluten meal and old-process linseed meal, as far as their influence on the yield of milk is concerned, in case of otherwise corresponding fodder rations, depends evidently in a controlling degree on two distinctly different circumstances, namely, the individual disposition and constitution of the animal on trial, and on the particular kind of coarse fodder constituent of the daily diet. In case of rowen as coarse fodder constituent, cotton-seed meal leads, in five out of six cases, both gluten meal and old-process linseed meal, while in case mixed ensilage or corn stover served as coarse feed the gluten meal competes well with cotton-seed meal. Old-process linseed meal has only been tested with rowen on the present occasion; it stands but little behind the gluten meal.

3. The density of the milk in case of the same cow varies but little during the experiment; the notable changes are apparently, in a controlling degree, due to the particular condition and individuality of the cow engaged in the trial.

FEEDING RECORD.

1. *Jessie.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn and Soja Bean Ensilage.	Corn Stover.					
1890-91.													
Nov. 1 to Nov. 21, . .	3.00	3.00	3.00	–	–	17.81	–	–	23.28	6.77	3.44	1: 4.51	926
Nov. 26 to Dec. 16, . .	3.00	3.00	–	–	3.00	16.23	–	–	21.88	5.30	4.13	1: 5.09	920
Dec. 22 to Jan. 11, . .	3.00	3.00	–	3.00	–	17.91	–	–	23.40	5.70	4.11	1: 4.85	965
Jan. 26 to Feb. 11, . .	3.00	3.00	3.00	–	–	5.00	43.94	–	24.99	7.54	3.31	1: 4.19	976
Feb. 14 to March 4, . .	3.00	3.00	–	–	3.00	5.00	47.11	–	25.87	8.48	3.05	1: 4.71	988
March 10 to March 25, . .	3.00	3.00	–	–	3.00	–	–	11.16	16.85	6.80	2.48	1: 6.33	951
March 28 to April 12, . .	3.00	3.00	3.00	–	–	–	–	13.59	18.84	5.50	3.43	1: 5.61	938
2. *Pearl.*													
Nov. 1 to Nov. 21, . .	3.00	3.00	3.00	–	–	21.19	–	–	26.19	10.74	2.44	1: 4.65	850
Nov. 26 to Dec. 16, . .	3.00	3.00	–	–	3.00	17.81	–	–	23.24	10.28	2.26	1: 5.14	877
Dec. 22 to Jan. 11, . .	3.00	3.00	–	3.00	–	18.26	–	–	23.70	10.84	2.19	1: 4.86	869
Feb. 14 to March 4, . .	3.00	3.00	–	–	3.00	5.00	48.05	–	26.14	12.19	2.14	1: 4.71	872
March 10 to March 25, . .	3.00	3.00	–	–	3.00	–	–	16.06	20.78	9.07	2.29	1: 7.06	853
March 28 to April 12, . .	3.00	3.00	3.00	–	–	–	–	14.50	19.57	7.34	2.67	1: 5.74	858
April 16 to May 6, . .	3.00	3.00	3.00	–	–	19.40	–	–	24.65	9.19	2.68	1: 4.57	853
May 11 to May 31, . .	3.00	3.00	–	–	3.00	18.33	–	–	23.69	9.24	2.56	1: 5.16	880

FEEDING RECORD — *Continued.*

3. *Pink.*

FEEDING PERIODS.	Feed consumed (Pounds) per Day.								Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn and Soja Bean Ensilage.	Corn Stover.					
1890-91.													
Nov. 1 to Nov. 21, . .	3.00	3.00	3.00	–	–	21.83	–	–	26.75	7.55	3.54	1:4.67	910
Nov. 26 to Dec. 16, . .	3.00	3.00	–	–	3.00	20.81	–	–	25.93	7.42	3.49	1:5.23	932
Jan. 26 to Feb. 11, . .	3.00	3.00	3.00	–	–	5.00	46.59	–	25.75	8.07	3.19	1:4.20	914
Feb. 14 to March 4, . .	3.00	3.00	–	–	3.00	5.60	48.79	–	26.35	8.30	3.17	1:4.71	948
March 10 to March 25, . .	3.00	3.00	–	–	3.00	–	–	15.75	20.53	7.05	2.91	1:7.01	947
March 28 to April 12, . .	3.00	3.00	3.00	–	–	–	–	17.50	21.97	6.56	3.35	1:6.15	952
April 16 to May 6, . .	3.00	3.00	3.00	–	–	19.57	–	–	24.80	7.48	3.32	1:4.58	946
May 11 to May 31, . .	3.00	3.00	–	–	3.00	19.38	–	–	24.60	7.63	3.22	1:5.19	973

4. *Roxy.*

FEEDING PERIODS.	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn and Soja Bean Ensilage.	Corn Stover.	Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
Nov. 1 to Nov. 21, . .	3.00	3.00	3.00	–	–	19.14	–	–	24.43	6.81	3.59	1:4.56	1,010
Nov. 26 to Dec. 16, . .	3.00	3.00	–	–	3.00	15.74	–	–	21.46	5.64	3.80	1:5.07	1,016
Dec. 22 to Jan. 11, . .	3.00	3.00	–	3.00	–	15.24	–	–	21.10	5.23	4.04	1:4.74	992

5. *Buttercup.*

Jan. 29 to Feb. 11, . .	3.00	3.00	3.00	–	–	5.00	42.61	–	24.60	13.36	1.84	1:4.18	781
Feb. 14 to March 4, . .	3.00	3.00	–	–	3.00	5.00	44.26	–	25.04	13.31	1.88	1:4.70	797
March 10 to March 25, . .	3.00	3.00	–	–	3.00	–	–	15.41	20.25	10.66	1.90	1:6.96	795
March 28 to April 12, . .	3.00	3.00	3.00	–	–	–	–	16.34	21.04	9.31	2.26	1:6.00	785
April 16 to May 6, . .	3.00	3.00	3.00	–	–	15.98	–	–	21.71	9.45	2.30	1:4.42	766
May 11 to May 31, . .	3.00	3.00	–	–	3.00	15.57	–	–	31.32	8.69	2.45	1:5.07	775

6. *Nancy.*

Nov. 1 to Nov. 21, . .	3.00	3.00	3.00	–	–	20.83	–	–	25.88	8.34	3.10	1:4.63	946
Nov. 26 to Dec. 16, . .	3.00	3.00	–	–	3.00	18.45	–	–	23.80	7.68	3.10	1:5.16	942
Dec. 22 to Jan. 11, . .	3.00	3.00	–	3.00	–	18.19	–	–	23.64	7.49	3.16	1:4.86	948
Jan. 26 to Feb. 11, . .	3.00	3.00	3.00	–	–	5.00	41.41	–	24.26	8.31	2.92	1:4.17	963
Feb. 14 to March 4, . .	3.00	3.00	–	–	3.00	5.00	42.63	–	24.57	8.54	2.88	1:4.69	987

7. *Clarissa.*

March 28 to April 12, . .	3.00	3.00	3.00	–	–	–	–	14.31	19.41	9.47	2.05	1:5.72	833
April 16 to May 6, . .	3.00	3.00	3.00	–	–	18.48	–	–	23.86	10.04	2.38	1:4.54	856
May 11 to May 31, . .	3.00	3.00	–	–	3.00	19.43	–	–	24.64	11.37	2.17	1:5.19	848

FEEDING RECORD — *Concluded.*

8. Juno.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn and Soja Bean Ensilage.	Corn Stover.					
1890-91.													
Nov. 1 to Nov. 21, . .	3.00	3.00	3.00	–	–	19.50	–	–	24.74	7.29	3.39	1:4.58	1,142
Nov. 26 to Dec. 16, . .	3.00	3.00	–	–	3.00	16.02	–	–	21.70	6.70	3.24	1:5.08	1,124
Dec. 22 to Jan. 11, . .	3.00	3.00	–	3.00	–	17.29	–	–	22.87	6.45	3.55	1:4.82	1,135
Jan. 26 to Feb. 11, . .	3.00	3.00	3.00	–	–	5.00	36.23	–	22.76	7.50	3.03	1:4.13	1,114

9. Favorite.

FEEDING PERIODS.	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn and Soja Bean Ensilage.	Corn Stover.	Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
March 10 to March 25, . .	3.00	3.00	–	–	3.00	–	–	11.16	16.85	11.33	1.49	1:6.33	826
March 28 to April 12, . .	3.00	3.00	3.00	–	–	–	–	8.22	14.54	7.89	1.84	1:4.76	775
April 16 to May 6, . .	3.00	3.00	3.00	–	–	14.48	–	–	20.42	10.05	2.03	1:4.34	809
May 11 to May 31, . .	3.00	3.00	–	–	3.00	14.19	–	–	20.13	9.60	2.10	1:5.01	801

TOTAL COST OF FEED PER QUART OF MILK.

1. Jessie.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn and Soja Bean Ensilage consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1890-91.												
Nov. 1 to Nov. 21, . .	142.21	6.77	63.00	63.00	63.00	–	–	374.00	–	–	$5 36	3.77
Nov. 26 to Dec. 16, . .	111.40	5.30	63.00	63.00	–	–	63.00	343.00	–	–	5 12	4.60
Dec. 22 to Jan. 11, . .	119.77	5.70	63.00	63.00	–	63.00	–	376.00	–	–	5 31	4.43
Jan. 26 to Feb. 11, . .	128.26	7.54	51.00	51.00	51.00	–	–	85.00	747.00	–	4 01	3.13
Feb. 14 to March 4, . .	161.02	8.48	57.00	57.00	–	–	57.00	95.00	895.00	–	4 69	2.91
March 10 to March 25, . .	108.72	6.80	48.00	48.00	–	–	48.00	–	–	178.50	2 39	2.20
March 28 to April 12, . .	88.02	5.50	48.00	48.00	48.00	–	–	–	–	217.50	2 48	2.82

2. Pearl.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn and Soja Bean Ensilage consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
Nov. 1 to Nov. 21, . .	225.58	10.74	63.00	63.00	63.00	–	–	445.00	–	–	$5 89	2.61
Nov. 26 to Dec. 16, . .	215.81	10.28	63.00	63.00	–	–	63.00	374.00	–	–	5 36	2.48
Dec. 22 to Jan. 11, . .	227.56	10.84	63.00	63.00	–	63.00	–	383.50	–	–	5 37	2.37
Feb. 14 to March 4, . .	231.74	12.19	57.00	57.00	–	–	57.00	95.00	913.00	–	4 62	1.99
March 10 to March 25, . .	145.12	9.07	48.00	48.00	–	–	48.00	–	–	257.00	2 58	1.78
March 28 to April 12, . .	117.44	7.34	48.00	48.00	48.00	–	–	–	–	232.00	2 52	2.15
April 16 to May 6, . .	193.05	9.19	63.00	63.00	63.00	–	–	407.50	–	–	5 61	2.91
May 11 to May 31, . .	194.07	9.24	63.00	63.00	–	–	63.00	385.00	–	–	5 44	2.80

TOTAL COST OF FEED PER QUART OF MILK — *Continued.*

3. *Pink.*

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn and Soja Bean Ensilage consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1890-91.												
Nov. 1 to Nov. 21, . .	158.49	7.55	63.00	63.00	63.00	–	–	458.50	–	–	$5 99	3.78
Nov. 26 to Dec. 16, . .	155.81	7.42	63.00	63.00	–	–	63.00	437.00	–	–	5 83	3.74
Jan. 26 to Feb. 11, . .	137.21	8.07	51.00	51.00	51.00	–	–	85.00	792.00	–	4 09	2.98
Feb. 14 to March 4, . .	155.79	8.30	57.00	57.00	–	–	57.00	95.00	990.00	–	4 75	3.05
March 10 to March 25, . .	112.79	7.05	48.00	48.00	–	–	48.00	–	–	252.00	2 57	2.28
March 28 to April 12, . .	105.00	6.56	48.00	48.00	48.00	–	–	–	–	280.00	2 64	2.51
April 16 to May 6, . .	157.09	7.48	63.00	63.00	63.00	–	–	411.00	–	–	5 63	3.58
May 11 to May 31, . .	160.23	7.63	63.00	63.00	–	–	63.00	407.00	–	–	5 60	3.49

4. *Roxy.*

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn and Soja Bean Ensilage consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
Nov. 1 to Nov. 21, . .	143.02	6.81	63.00	63.00	63.00	–	–	402.00	–	–	$5 57	3.89
Nov. 26 to Dec. 16, . .	118.49	5.64	63.00	63.00	–	–	63.00	330.50	–	–	5 03	4.25
Dec. 22 to Jan. 11, . .	109.77	5.23	63.00	63.00	–	63.00	–	320.00	–	–	4 89	4.45

5. *Buttercup.*

Jan. 29 to Feb. 11,	186.98	13.36	42.00	42.00	42.00	–	–	70.00	596.50	–	$3 27	1.75
Feb. 14 to March 4,	252.80	13.31	57.00	57.00	–	–	57.00	95.00	841.00	–	4 49	1.78
March 10 to March 25,	170.58	10.66	48.00	48.00	–	–	48.00	–	–	246.50	2 56	1.50
March 28 to April 12,	148.95	9.31	48.00	48.00	48.00	–	–	–	–	261.50	2 59	1.74
April 16 to May 6,	198.49	9.45	63.00	63.00	63.00	–	–	335.50	–	–	5 07	2.55
May 11 to May 31,	182.56	8.69	63.00	63.00	–	–	63.00	327.00	–	–	5 00	2.74

6. *Nancy.*

Nov. 1 to Nov. 21,	175.23	8.34	63.00	63.00	63.00	–	–	437.50	–	–	$5 83	3.33
Nov. 26 to Dec. 16,	161.28	7.68	63.00	63.00	–	–	63.00	387.50	–	–	5 46	3.39
Dec. 22 to Jan 11,	157.21	7.49	63.00	63.00	–	63.00	–	382.00	–	–	5 35	3.40
Jan 26 to Feb. 11,	141.28	8.31	51.00	51.00	51.00	–	–	85.00	704.00	–	3 93	2.78
Feb. 14 to March 4,	162.33	8.54	57.00	57.00	–	–	57.00	95.00	810.00	–	4 44	2.73

7. *Clarissa.*

March 28 to April 12,	151.51	9.47	48.00	48.00	48.00	–	–	–	–	229.00	$2 51	1.66
April 16 to May 6,	210.81	10.04	63.00	63.00	63.00	–	–	388.00	–	–	5 46	2.59
May 11 to May 31,	238.72	11.37	63.00	63.00	–	–	63.00	408.00	–	–	5 61	2.35

TOTAL COST OF FEED PER QUART OF MILK — *Concluded.*

8. *Juno.*

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn and Soja Bean Ensilage consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1890-91.												
Nov. 1 to Nov. 21, . .	153.14	7.29	63.00	63.00	63.00	–	–	409.50	–	–	$5 62	3.67
Nov. 26 to Dec. 16, . .	140.70	6.70	63.00	63.00	–	–	63.00	336.50	–	–	5 07	3.60
Dec. 22 to Jan. 11, . .	135.35	6.45	63.00	63.00	–	63.00	–	363.00	–	–	5 21	3.85
Jan. 26 to Feb. 11, . .	127.56	7.50	51.00	51.00	51.00	–	–	85.00	616.00	–	3 78	2.96

9. *Favorite.*

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn and Soja Bean Ensilage consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
March 10 to March 25, . .	181.28	11.33	48.00	48.00	–	–	48.00	–	–	178.50	$2 39	1.32
March 28 to April 12, . .	126.30	7.89	48.00	48.00	48.00	–	–	–	–	131.50	2 27	1.80
April 16 to May 6, . .	211.05	10.05	63.00	63.00	63.00	–	–	304.00	–	–	4 83	2.29
May 11 to May 31, . .	201.51	9.60	63.00	63.00	–	–	63.00	298.00	–	–	4 79	2.38

NET COST OF MILK AND MANURIAL VALUE OF FEED CONSUMED.

1. *Jessie.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1890-91.					Cents.	Pounds.
Nov. 1 to Nov. 21, .	$5 36	$2 81	$2 25	$3 11	2.19	920
Nov. 26 to Dec. 16, .	5 12	2 42	1 94	3 18	2.85	947
Dec. 22 to Jan. 11, .	5 31	2 67	2 14	3 17	2.65	998
Jan. 26 to Feb. 11, .	4 01	2 53	2 02	1 99	1.55	973
Feb. 14 to Mar. 4, .	4 69	2 68	2 14	2 55	1.58	995
Mar. 10 to Mar. 25, .	2 39	1 15	0 92	1 47	1.35	940
Mar. 28 to Apr. 12, .	2 48	1 41	1 13	1 35	1.53	932
Total, . .	$29 36	$15 67	$12 54	$16 82	-	-

2. *Pearl.*

Nov. 1 to Nov. 21, .	$5 89	$3 08	$2 46	$3 43	1.52	864
Nov. 26 to Dec. 16, .	5 36	2 55	2 04	3 32	1.54	876
Dec. 22 to Jan. 11, .	5 37	2 70	2 16	3 21	1.41	876
Feb. 14 to Mar. 4, .	4 62	2 71	2 17	2 45	1.06	873
Mar. 10 to Mar. 25, .	2 58	1 29	1 03	1 55	1.07	850
Mar. 28 to Apr. 12, .	2 52	1 44	1 15	1 37	1.17	865
Apr. 16 to May 6, .	5 61	2 94	2 35	3 26	1.69	842
May 11 to May 31, .	5 44	2 59	2 07	3 37	1.74	874
Total, . .	$37 39	$19 30	$15 43	$21 96	-	-

3. *Pink.*

Nov. 1 to Nov. 21, .	$5 99	$3 14	$2 51	$3 48	2.20	910
Nov. 26 to Dec. 16, .	5 83	2 80	2 24	3 59	2.30	950
Jan. 26 to Feb. 11, .	4 09	2 60	2 08	2 01	1.47	922
Feb. 14 to Mar. 4, .	4 75	2 83	2 26	2 49	1.60	953
Mar. 10 to Mar. 25, .	2 57	1 28	1 02	1 55	1.37	940
Mar. 28 to Apr. 12, .	2 64	1 52	1 22	1 42	1.35	970
Apr. 16 to May 6, .	5 63	2 95	2 36	3 27	2.08	940
May 11 to May 31, .	5 60	2 68	2 14	3 46	2.16	973
Total, . .	$37 10	$19 80	$15 83	$21 27	-	-

NET COST OF MILK AND MANURIAL VALUE OF FEED — *Continued.*

4. Roxy.

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1890-91.					Cents.	Pounds.
Nov. 1 to Nov. 21, .	$5 57	$2 92	$2 34	$3 23	2.26	1,008
Nov. 26 to Dec. 16, .	5 03	2 38	1 90	3 13	2.64	1,034
Dec. 22 to Jan. 11, .	4 89	2 45	1 96	2 93	2.67	1,010
Total, . .	$15 49	$7 75	$6 20	$9 29	–	–

5. Buttercup.

Jan. 29 to Feb. 11, .	$3 27	$2 05	$1 64	$1 63	0.87	800
Feb. 14 to Mar. 4, .	4 49	2 60	2 08	2 41	1.29	797
Mar. 10 to Mar. 25, .	2 56	1 27	1 01	1 55	0.91	800
Mar. 28 to Apr. 12, .	2 59	1 49	1 19	1 40	0.94	795
Apr. 16 to May 6, .	5 07	2 66	2 13	2 94	1.48	753
May 11 to May 31, .	5 00	2 36	1 89	3 11	1.70	775
Total, . .	$22 98	$12 43	$9 94	$13 04	–	–

6. Nancy.

Nov. 1 to Nov. 21, .	$5 83	$3 06	$2 45	$3 38	1.93	925
Nov. 26 to Dec. 16, .	5 46	2 60	2 08	3 38	2.10	960
Dec. 22 to Jan. 11, .	5 35	2 70	2 16	3 19	2.03	972
Jan. 26 to Feb. 11, .	3 93	2 47	1 97	1 96	1.39	963
Feb. 14 to Mar. 4, .	4 44	2 56	2 05	2 39	1.47	985
Total, . .	$25 01	$13 39	$10 71	$14 30	–	–

7. Clarissa.

Mar. 28 to Apr. 12, .	$2 51	$1 43	$1 14	$1 37	0.90	843
Apr. 16 to May 6, .	5 46	2 86	2 29	3 17	1.50	835
May 11 to May 31, .	5 61	2 68	2 14	3 47	1.45	855
Total, . .	$13 58	$6 97	$5 57	$8 01	–	–

NET COST OF MILK AND MANURIAL VALUE OF FEED — *Concluded.*

8. Juno.

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1890-91.					Cents.	Pounds.
Nov. 1 to Nov. 21, .	$5 62	$2 95	$2 36	$3 26	2.13	1,130
Nov. 26 to Dec. 16, .	5 07	2 40	1 92	3 15	2.24	1,143
Dec. 22 to Jan. 11, .	5 21	2 62	2 10	3 11	2.30	1,150
Jan 26 to Feb. 11, .	3 78	2 34	1 87	1 91	1.50	1,105
Total, . .	$19 68	$10 31	$8 25	$11 43	–	–

9. Favorite.

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
Mar. 10 to Mar. 25, .	$2 39	$1 15	$0 92	$1 47	0.81	790
Mar. 28 to Apr. 12, .	2 27	1 26	1 01	1 26	0.99	785
Apr. 16 to May 6, .	4 83	2 53	2 02	2 81	1.33	782
May 11 to May 31, .	4 79	2 25	1 80	2 99	1.48	797
Total, . .	$14 28	$7 19	$5 75	$8 53	–	–

Composition of Fodder Articles fed during the Above-described Feeding Experiment.

Corn Meal (Average).

1890-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	13.26	265.20	–	–	1 : 8.62
Dry matter, . . .	86.74	1,734.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	1.72	34.40	–	–	
" cellulose, . . .	2.28	45.60	21.89	48	
" fat, ...	4.90	98.00	83.30	85	
" protein (nitrogenous matter), . .	12.94	258.80	204.45	79	
Non-nitrogenous extract matter, ...	78.16	1,563.20	1,531.94	98	
	100.00	2,000.00	1,841.58	–	

Composition of Fodder Articles, etc. — Continued.

Wheat Bran (*Average*).

1890-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	12.11	242.20	–	–	1 : 3.86
Dry matter, . . .	87.89	1,757.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	7.40	148.00	–	–	
" cellulose, . . .	12.17	243.40	58.42	24	
" fat, ...	5.04	100.80	71.57	71	
" protein (nitrogenous matter), . .	18.48	369.60	288.29	78	
Non-nitrogenous extract matter, ...	56.91	1,138.20	876.41	77	
	100.00	2,000.00	1,294.69	–	

Cotton-seed Meal (*Average*).

1890-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	9.77	195.40	–	–	1 : 1.37
Dry matter, . . .	90.23	1,804.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	8.18	163.60	–	–	
" cellulose, . . .	7.74	154.80	–	–	
" fat, ...	11.33	226.60	199.41	88	
" protein (nitrogenous matter), . .	44.41	888.20	754.97	85	
Non-nitrogenous extract matter, ...	28.34	566.80	538.46	95	
	100.00	2,000.00	1,492.84	–	

Composition of Fodder Articles, etc. — Continued.

Old-process Linseed Meal.

1890-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	8.72	174.40	–	–	1 : 1.93
Dry matter,	91.28	1,825.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	5.96	119.20	–	–	
" cellulose,	8.23	164.60	42.79	26	
" fat,	9.87	197.40	179.63	91	
" protein (nitrogenous matter),	36.19	723.80	629.70	87	
Non-nitrogenous extract matter,	39.75	795.00	723.45	91	
	100.00	2,000.00	1,575.57	–	

Gluten Meal.

1890-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	10.90	218.00	–	–	1 : 2.44
Dry matter,	89.10	1,782.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.02	20.40	–	–	
" cellulose,	1.28	25.60	15.87	62	
" fat,	7.36	147.20	125.12	85	
" protein (nitrogenous matter),	34.79	695.80	549.68	79	
Non-nitrogenous extract matter,	55.55	1,111.00	1,011.01	91	
	100.00	2,000.00	1,701.68	–	

Composition of Fodder Articles, etc. — Continued.

Rowen (Average).

1890-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds	Pounds Digestible in a Ton of 2,000 Pounds	Per Cent. of Digestibility of Constituents	Nutritive Ratio.
Moisture at 100° C., . .	13.90	278.00	-	-	1 : 6.35
Dry matter, . . .	86.10	1,722.00	-	-	
	100.00	2,000.00	-	-	
Analysis of Dry Matter.					
Crude ash, ...	8.28	165.60	-	-	
" cellulose, . . .	28.88	577.60	369.66	64	
" fat, ...	3.91	78.20	35.97	46	
" protein (nitrogenous matter), . .	13.45	269.00	166.78	62	
Non-nitrogenous extract matter, ...	45.48	909.60	600.34	66	
	100.00	2,000.00	1,172.75	-	

Corn and Soja Bean Ensilage.

1890-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	71.03	1,420.60	-	-	1 : 1.94
Dry matter, . . .	28.97	579.40	-	-	
	100.00	2,000.00	-	-	
Analysis of Dry Matter.					
Crude ash, ...	11.04	220.80	-	-	
" cellulose, . . .	27.84	556.80	339.65	61	
" fat, ...	5.35	107.00	69.55	65	
" protein (nitrogenous matter), . .	15.27	305.40	216.83	71	
Non-nitrogenous extract matter, ...	40.50	810.00	558.90	69	
	100.00	2,000.00	1,184.93	-	

Composition of Fodder Articles, etc. — Concluded.

Corn Stover.

1890-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	19.89	397.80	–	–	1 : 14.84
Dry matter, . . .	80.11	1,602.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	6.33	126.60	–	–	
" cellulose, . . .	34.59	691.80	498.10	72	
" fat, ...	1.28	25.60	19.20	75	
" protein (nitrogenous matter), . .	5.74	114.80	83.80	73	
Non-nitrogenous extract matter, ...	52.06	1,041.20	697.60	67	
	100.00	2,000.00	1,298.70	–	

3. *Summer Feeding Experiment with Milch Cows, July 6 to Sept. 26, 1891.*

Green feed: vetch and oats, soja beans and fodder corn.

Grain feed: corn meal, wheat bran, dried brewers' grain, gluten meal (Chicago).

The feeding experiment here under discussion is a continuation of similar ones carried on during the summer season in preceding years (since 1887) for the purpose of ascertaining the comparative feeding value and the general economy of various reputed green fodder crops in the dairy industry. Our late observation includes, of green crops, besides vetch and oats and soja beans of former years, as an addition the green fodder corn. The two first named green crops were cut for feed at the beginning of blooming, and they were fed until our supply was either exhausted or until they were fully matured yet still succulent. The green fodder corn was first cut for feed when the kernels were fully developed yet in the milk. The grain feed ration consisted throughout the entire experiment of corn meal and gluten meal, alternating either with wheat bran or dried brewers' grain. The daily ration of grain feed amounted throughout the entire experiment to nine pounds per head; three pounds of corn meal and three pounds of Chicago gluten meal *with either three pounds of wheat bran or with three pounds of dried brewers' grain, for the purpose of comparing the economical merits of these two articles in connection with the production of milk.*

The daily rations of coarse feed consisted of five pounds of rowen — hay of second cut of upland meadows — and of either a mixed green crop of vetch and oats, or of green soja bean or of green fodder corn. The daily consumption per head of grain feed and of hay, as far as quantity is concerned, remained the same in case of every animal during the entire experiment, while that of the green fodder crops was governed by the appetite of each animal on trial. The quantity daily consumed decreased as a rule with their advancing growth, on account of the steady increase of solid matter in the plants. The daily consumption of vetch and oats varied at different feeding periods from 45 to 35 pounds in case of the same animals, and that of soja beans from 44 to 38 pounds, while that of green fodder corn varied from 50 to 38 pounds in case of different animals (fifth feeding period).

A record of the composition and general character of the various fodder constituents of the daily diet will be found farther on.

Five cows, grades of various descriptions and in different milking periods, served in the trial.

The subsequent statement shows the average composition of the daily fodder rations used in the trial during five succeeding feeding periods into which the entire experiment was divided.

Statement of the Average Daily Fodder Rations used during the Different Feeding Periods.

I

Corn meal,	3.00 lbs.
Brewers' grain,	3.00 "
Gluten meal,	3.00 "
Rowen,	5.00 "
Vetch and oats (green),	47.24 "
Total cost,	22.39 cts
Net cost,	12.96 "
Manurial value obtainable,	9.43 "
Nutritive ratio,	1:6.17

Average Daily Fodder Rations, etc. — Concluded.

II.

Corn meal,	3.00	lbs.
Wheat bran,	3.00	"
Gluten meal,	3.00	"
Rowen,	5.00	"
Vetch and oats (green),	36.42	"
Total cost,	20.91	cts.
Net cost,	12.52	"
Manurial value obtainable,	8.39	"
Nutritive ratio,	1:6.29	

III.

Corn meal,	3.00	lbs.
Wheat bran,	3.00	"
Gluten meal,	3.00	"
Rowen,	5.00	"
Soja beans (green),	51.28	"
Total cost,	27.18	cts.
Net cost,	17.32	"
Manurial value obtainable,	9.86	"
Nutritive ratio,	1:5.07	

IV.

Corn meal,	3.00	lbs.
Brewers' grain,	3.00	"
Gluten meal,	3.00	"
Rowen,	5.00	"
Soja beans,	47.34	"
Total cost,	26.31	cts.
Net cost,	16.65	"
Manurial value obtainable,	9.66	"
Nutritive ratio,	1:4.76	

V.

Corn meal,	3.00	lbs.
Brewers' grain,	3.00	"
Gluten meal,	3.00	"
Rowen,	5.00	"
Fodder corn (green),	39.22	"
Total cost,	20.80	cts.
Net cost,	12.67	"
Manurial value obtainable,	8.13	"
Nutritive ratio,	1:6.17	

Local Market Cost of the Various Articles of Fodder used (per Ton).

Corn meal,	$31 00
Brewers' grain,	23 00
Wheat bran,	23 00
Gluten meal,	27 00
Rowen,	15 00
Vetch and oats (green),	2 75
Fodder corn (green),	2 50
Soja beans (green),	4 40

Essential Fertilizing Constituents of the Above Fodder Articles.

Nitrogen, 15 cents; phosphoric acid, 5½ cents; potassium oxide, 4½ cents per pound.

	Corn Meal.	Brewers' Grain.	Wheat Bran.	Gluten Meal.	Rowen.	Vetch and Oats.	Fodder Corn.	Soja Beans.
Moisture, . .	15.31	12.00	12.99	11.11	13.90	67.49	71.86	74.23
Nitrogen, . .	1.651	3.299	2.249	4.741	1.853	.459	.343	.565
Phosphoric acid,	.693	1.192	2.793	.413	.464	.202	.195	.183
Potassium oxide,	.426	1.466	1.592	.044	1.966	.487	.430	.297
Valuation per 2,000 pounds, .	$6 10	$12 52	$11 25	$14 72	$7 84	$2 04	$1 63	$2 16

History of Cows (Grades).

NAME.	Breed.	Age (Years).	Last Calf dropped.	Daily Yield of Milk at beginning of Trial (Quarts).	No. of Months on Trial.
Cora, . . .	Grade Jersey, .	7	April 16, 1891,	11–12	3
Pearl, . .	Native, . .	6	Aug. 8, 1890,	8–9	3
Buttercup, . .	Grade Ayrshire,	5	Jan. 2, 1891,	8–9	3
Lucy, . . .	Grade Ayrshire,	5	June 2, 1891,	12–13	3
Clarissa, . .	Grade Durham,	7	March 14, 1891,	9–10	3

Yield of Milk during Different Feeding Periods (Quarts).

	Cora.	Pearl.	Buttercup.	Lucy.	Clarissa.
Period I., ...	11.29	8.11	8.34	12.26	9.49
Period II., ...	11.34	8.70	8.73	12.78	9.31
Period III., ...	11.24	8.63	8.76	12.85	10.37
Period IV., ...	11.57	8.95	8.85	13.26	10.99
Period V., ...	10.70	8.92	8.64	12.01	9.98
Average, . . .	11.23	8.66	8.66	12.63	10.03

Conclusions. — The results of the past season obtained in this connection are very encouraging, as will be seen from the subsequent brief abstract when compared with those noticed in preceding years.

1. The yield of milk is well maintained during the entire experiment of three months. The average daily yield of milk of the various cows for the entire experiment is in four out of five cases *larger* than their yield at the beginning of the observation; in the fifth case there is practically no change (Cora). The largest average yield of milk was noticed, without any exception as to a particular cow, in case of soja bean as green fodder and dried brewers' grain as ingredient of the daily grain feed ration (fourth feeding period). Green fodder corn leads in three out of five cases the green vetch and oats when fed with dried brewers' grain.

2. The amount of dry vegetable matter consumed per quart of milk produced varies in case of different cows from 1.77 pounds (Cora) to 3.33 pounds (Pearl). The amount consumed in case of the same cows varies in different feeding periods from 1.77 to 2.25 pounds (Cora) and from 2.44 to 3.17 pounds (Buttercup).

3. The total cost of feed consumed per quart of milk produced differs in case of different animals for the same feeding period from 1.69 to 2.30 cents (Lucy and Pearl, fifth feeding period) ; as far as different feeding periods are concerned it varies in one case from 1.69 to 2.30 cents (Lucy) and in another case from 2.24 to 2.91 cents (Clarissa).

4. The net cost of feed per quart of milk produced varies from 1.01 to 1.43 cents for the same feeding period in case of different animals (Lucy and Pearl, second feeding period).

5. The obtainable manurial value amounts on an average to three-sevenths of the market cost of the feed consumed. The green vetch and oats leads in this connection.

6. The quality of the milk is in every instance improved in the percentage of solids during the experiment without showing any perceptible decrease in yield. Individuality of the animal and stage of lactation affect the results to a controlling extent.

7. Brewers' grain has served as an excellent substitute for wheat bran in our diet for milch cows.

FEEDING RECORD.

Cora: *Age, seven years; grade Jersey; last calf, April 16, 1891.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Amount of Dry Vegetable Matter contained in the Daily Fodder consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Each Feeding Period.
	Corn Meal.	Brewers' Grain.	Wheat Bran.	Gluten Meal.	Rowen.	Vetch and Oats.	Soja Beans.	Fodder Corn.					
1891.													Pounds.
July 6 to July 21, . .	3.00	3.00	-	3.00	5.00	40.75	-	-	25.45	11.29	2.25	1 : 6.00	1,053
July 24 to Aug. 2, . .	3.00	-	3.00	3.00	5.00	24.30	-	-	20.02	11.34	1.77	1 : 5.91	1,039
Aug. 6 to Aug. 17, . .	3.00	-	3.00	3.00	5.00	-	44.67	-	23.63	11.24	2.10	1 : 5.05	1,025
Aug. 21 to Sept. 3, . .	3.00	3.00	-	3.00	5.00	-	42.86	-	23.25	11.57	2.01	1 : 4.74	1,013
Sept. 7 to Sept. 26, . .	3.00	3.00	-	3.00	5.00	-	-	37.45	22.74	10.71	2.12	1 : 6.13	1,030
Pearl: *Age, six years; native; last calf, Aug. 8, 1890.*													
July 6 to July 18, . .	3.00	3.00	-	3.00	5.00	45.62	-	-	27.03	8.11	3.33	1 : 6.12	923
July 24 to Aug. 2, . .	3.00	-	3.00	3.00	5.00	35.90	-	-	23.79	8.70	2.73	1 : 6.29	928
Aug. 6 to Aug 17, . .	3.00	-	3.00	3.00	5.00	-	43.08	-	23.22	8.61	2.69	1 : 5.05	907
Aug 25 to Sept. 3, . .	3.00	3.00	-	3.00	5.00	-	38.70	-	22.17	8.95	2.48	1 : 4.72	890
Sept. 7 to Sept. 26, . .	3.00	3.00	-	3.00	5.00	-	-	37.35	22.71	8.92	2.55	1 : 6.13	864

BUTTERCUP: *Age, five years; grade, Ayrshire; last calf, Jan. 2, 1891.*

July 6 to July 21, . .	3.00	3.00	–	3.00	5.00	43.75	–	–	26.42	8.34	3.17	1:6.08	807
July 24 to Aug. 2, . .	3.00	–	3.00	3.00	5.00	29.60	–	–	21.74	8.73	2.49	1:6.09	840
Aug. 6 to Aug. 17, . .	3.00	–	3.00	3.00	5.00	–	42.17	–	22.99	8.76	2.62	1:5.05	816
Aug. 21 to Sept. 3, . .	3.00	3.00	–	3.00	5.00	–	36.58	–	21.63	8.85	2.44	1:4.70	826
Sept. 7 to Sept. 26, . .	3.00	3.00	–	3.00	5.00	–	–	33.90	21.74	8.64	2.52	1:6.00	864

LUCY: *Age, five years; grade, Ayrshire; last calf, June 2, 1891.*

July 6 to July 21, . .	3.00	3.00	–	3.00	5.00	49.38	–	–	28.25	12.26	2.30	1:6.23	762
July 24 to Aug. 2, . .	3.00	–	3.00	3.00	5.00	44.70	–	–	26.65	12.78	2.09	1:6.52	807
Aug. 6 to Aug. 17, . .	3.00	–	3.00	3.00	5.00	–	61.92	–	28.08	12.85	2.19	1:5.09	790
Aug. 21 to Sept. 3, . .	3.00	3.00	–	3.00	5.00	–	58.50	–	27.28	13.26	2.06	1:4.81	798
Sept. 7 to Sept. 26, . .	3.00	3.00	–	3.00	5.00	–	–	35.75	22.26	12.01	1.85	1:6.01	786

CLARISSA: *Age, seven years; grade, Durham; last calf, March 14, 1891.*

July 6 to July 21, . .	3.00	3.00	–	3.00	5.00	56.69	–	–	30.63	9.49	3.23	1:6.40	889
July 24 to Aug. 2, . .	3.00	–	3.00	3.00	5.00	47.60	–	–	27.59	9.31	2.96	1:6.59	923
Aug. 6 to Aug. 17, . .	3.00	–	3.00	3.00	5.00	–	64.58	–	28.76	10.37	2.77	1:5.10	890
Aug. 21 to Sept. 3, . .	3.00	3.00	–	3.00	5.00	–	60.07	–	27.68	10.99	2.52	1:4.81	882
Sept. 7 to Sept. 26, . .	3.00	3.00	–	3.00	5.00	–	–	51.65	26.73	9.98	2.68	1:6.57	909

TOTAL COST OF FEED PER QUART OF MILK.

Cora.

FEEDING PERIODS.		Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Brewers' Grain consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Vetch and Oats consumed (Pounds).	Total Amount of Soja Beans consumed (Pounds).	Total Amount of Fodder Corn consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1891.													
July 6 to July 21,	.	180.70	11.29	48.00	48.00	–	48.00	80.00	652.00	–	–	$3 44	1.90
July 24 to Aug. 2,	.	113.30	11.34	30.00	–	30.00	30.00	50.00	243.00	–	–	1 92	1.69
Aug. 6 to Aug. 17,	.	134.88	11.24	36.00	–	36.00	36.00	60.00	–	536.00	–	3 09	2.29
Aug. 21 to Sept. 3,	.	161.98	11.57	42.00	42.00	–	42.00	70.00	–	600.00	–	3 55	2.19
Sept 7 to Sept. 26,	.	214.19	10.71	60.00	60.00	–	60.00	100.00	–	–	749.00	4 12	1.92

Pearl.

July 6 to July 18,	.	105.46	8.11	39.00	39.00	–	39.00	65.00	593.00	–	–	$2 89	2.74
July 24 to Aug. 2,	.	86.98	8.70	30.00	–	30.00	30.00	50.00	359.00	–	–	2 08	2.39
Aug. 6 to Aug. 17,	.	103.60	8.63	36.00	–	36.00	36.00	60.00	–	517.00	–	3 05	2.94
Aug. 25 to Sept. 3,	.	89.53	8.95	30.00	30.00	–	30.00	50.00	–	387.00	–	2 41	2.73
Sept. 7 to Sept. 26,	.	178.49	8.92	60.00	60.00	–	60.00	100.00	–	–	747.00	4 11	2.30

Buttercup.

July 6 to July 21, .	133.50	8.34	48.00	48.00	–	48.00	80.00	700.00	–	–	$3 50	2.62
July 24 to Aug. 2, .	87.33	8.73	30.00	–	30.00	30.00	50.00	296.00	–	–	2 00	2.29
Aug. 6 to Aug. 17, .	105.12	8.76	36.00	–	36.00	36.00	60.00	–	506.00	–	3 02	2.86
Aug. 21 to Sept. 3, .	123.95	8.85	42.00	42.00	–	42.00	70.00	–	512.00	–	3 36	2.71
Sept. 7 to Sept. 26, .	172.79	8.64	60.00	60.00	–	60.00	100.00	–	–	678.00	4 03	2.33

Lucy.

July 6 to July 21, .	196.16	12.26	48.00	48.00	–	48.00	80.00	790.00	–	–	$3 63	1.85
July 24 to Aug. 2, .	127.79	12.78	30.00	–	30.00	30.00	50.00	447.00	–	–	2 20	1.72
Aug. 6 to Aug. 17, .	154.19	12.85	36.00	–	36.00	36.00	60.00	–	743.00	–	3 54	2.30
Aug. 21 to Sept. 3, .	185.58	13.26	42.00	42.00	–	42.00	70.00	–	819.00	–	4 03	2.17
Sept. 7 to Sept. 26, .	240.12	12.01	60.00	60.00	–	60.00	100.00	–	–	715.00	4 07	1.69

Clarissa.

July 6 to July 21, .	151.86	9.49	48.00	48.00	–	48.00	80.00	907.00	–	–	$3 79	2.50
July 24 to Aug. 2, .	93.14	9.31	30.00	–	30.00	30.00	50.00	476.00	–	–	2 24	2.40
Aug. 6 to Aug. 17, .	124.42	10.37	36.00	–	36.00	36.00	60.00	–	775.00	–	3 62	2.91
Aug. 21 to Sept. 3, .	153.84	10.99	42.00	42.00	–	42.00	70.00	–	841.00	–	4 08	2.65
Sept. 7 to Sept. 26, .	199.53	9.98	60.00	60.00	–	60.00	100.00	–	–	1,033.00	4 47	2.24

NET COST OF MILK AND MANURIAL VALUE OF FEED.

Cora.

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1891.					Cents.	Pounds.
July 6 to July 21, .	$3 44	$1 78	$1 42	$2 02	1.12	1,080
July 24 to Aug. 2, .	1 92	0 93	0 74	1 18	1.04	1,055
Aug. 6 to Aug. 17, .	3 09	1 39	1 11	1 98	1.47	1,015
Aug. 21 to Sept. 3, .	3 55	1 62	1 30	2 25	1.39	1,032
Sept. 7 to Sept. 26, .	4 12	2 00	1 60	2 52	1.18	1,020
Total, . .	$16 12	$7 72	$6 17	$9 95	–	–
Pearl.						
July 6 to July 18, .	$2 89	$1 50	$1 20	$1 69	1.60	972
July 24 to Aug. 2, .	2 08	1 05	0 84	1 24	1.43	945
Aug. 6 to Aug. 17, .	3 05	1 37	1 10	1 95	1.88	920
Aug. 25 to Sept. 3, .	2 44	1 12	0 90	1 54	1.72	920
Sept. 7 to Sept. 26, .	4 11	2 00	1 60	2 51	1.41	930
Total, . .	$14 57	$7 04	$5 64	$8 93	–	–
Buttercup.						
July 6 to July 21, .	$3 50	$1 82	$1 46	$2 04	1.53	832
July 24 to Aug. 2, .	2 00	0 98	0 78	1 22	1.40	845
Aug. 6 to Aug. 17, .	3 02	1 36	1 09	1 93	1.84	812
Aug. 21 to Sept. 3, .	3 36	1 52	1 22	2 14	1.72	850
Sept. 7 to Sept. 26, .	4 03	1 94	1 55	2 48	1.44	858
Total, . .	$15 91	$7 62	$6 10	$9 81	–	–
Lucy.						
July 6 to July 21, .	$3 63	$1 92	$1 54	$2 09	1.07	793
July 24 to Aug. 2, .	2 20	1 14	0 91	1 29	1.01	835
Aug. 6 to Aug. 17, .	3 54	1 61	1 29	2 25	1.46	785
Aug. 21 to Sept. 3, .	4 03	1 85	1 48	2 55	1 37	815
Sept. 7 to Sept. 26, .	4 07	1 97	1 58	2 49	1 04	765
Total, . .	$17 47	$8 49	$6 80	$10 67	–	–

NET COST OF MILK AND MANURIAL VALUE OF FEED — *Concluded.*

Clarissa.

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1891.					Cents.	Pounds.
July 6 to July 21, .	$3 79	$2 04	$1 63	$2 16	1.42	911
July 24 to Aug. 2,	2 24	1 17	0 94	1 30	1.40	930
Aug. 6 to Aug. 17, .	3 62	1 65	1 32	2 30	1.85	890
Aug. 21 to Sept. 3, .	4 08	1 88	1 50	2 58	1.68	907
Sept 7 to Sept. 26, .	4 47	2 23	1 78	2 69	1.35	905
Total, . .	$18 20	$8 97	$7 17	$11 03	–	–

Statement of the Average of Analyses of Milk made during the Different Feeding Periods.

PERIODS.		Cora.	Pearl.	Buttercup.	Lucy.	Clarissa.
I., . .	Solids, per cent.,	13.05	13.96	13.48	13.58	13.59
	Fat, per cent., .	4.24	4.26	3.92	4.29	4.58
II., . .	Solids, per cent.,	12.70	13.55	12.59	13.48	13.16
	Fat, per cent., .	3.98	3.83	3.28	4.26	4.17
III., . .	Solids, per cent.,	12.99	14.63	12.68	13.25	13.43
	Fat, per cent., .	4.39	4.87	3.67	4.27	4.59
IV., . .	Solids, per cent.,	13.68	14.67	12.99	13.98	14.54
	Fat, per cent., .	4.63	4.62	3.58	4.54	4.84
V., . .	Solids, per cent.,	13.30	14.92	13.55	14.33	14.65
	Fat, per cent., .	3.88	4.25	3.83	4.97	4.93

Corn Meal.

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	15.31	303.20	–	–	1 : 9.23
Dry matter,	84.69	1,697.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.72	34.40	–	–	
" cellulose,	2.17	43.40	20.83	48	
" fat,	4.84	96.80	82.28	85	
" protein (nitrogenous matter),	12.18	243.60	192.44	79	
Non-nitrogenous extract matter,	79.09	1,581.80	1,550.16	98	
	100.00	2,000.00	1,845.71	–	

Gluten Meal.

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	11.11	222.20	–	–	1 : 2.66
Dry matter,	88.89	1,777.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.65	33.00	–	–	
" cellulose,	0.73	14.60	9.05	62	
" fat,	9.22	184.40	156.74	85	
" protein (nitrogenous matter),	33.34	666.80	526.77	79	
Non-nitrogenous extract matter,	55.06	1,101.20	1,002.09	91	
	100.00	2,000.00	1,694.65	–	

Brewers' Grain.

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	12.00	240.00	–	–	1 : 2.95
Dry matter, . . .	88.00	1,760.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	4.46	89.20	–	–	
" cellulose, . . .	15.31	306.20	122.48	40	
" fat, ...	6.10	122.00	101.26	83	
" protein (nitrogenous matter), . .	23.43	468.60	346.76	74	
Non-nitrogenous extract matter, ...	50.70	1,014.00	648.96	64	
	100.00	2,000.00	1,219.46	–	

Wheat Bran.

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	12.99	259.80	–	–	1 : 4.73
Dry matter, . . .	87.01	1,740.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	6.23	124.60	–	–	
" cellulose, . . .	10.47	209.40	50.26	24	
" fat, ...	5.37	107.40	76.25	71	
" protein (nitrogenous matter), . .	16.16	323.20	252.10	78	
Non-nitrogenous extract matter, ...	61.77	1,235.40	951.26	77	
	100.00	2,000.00	1,329.87	–	

Vetch and Oats.

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	64.77	1,295.40	–	–	1 : 10.01
Dry matter, . . .	35.23	704.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	7.97	159.40	–	–	
" cellulose, . . .	30.77	615.40	–	–	
" fat, ...	2.58	51.60	25.80	50	
" protein (nitrogenous matter), . .	8.83	176.60	105.96	60	
Non-nitrogenous extract matter, ...	49.85	997.00	997.00	100	
	100.00	2,000.00	1,128.76	–	

Soja Beans.

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents	Nutritive Ratio.
Moisture at 100° C., . .	72.22	1,444.40	–	–	1 : 5.35
Dry matter, . . .	27.78	555.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	6.39	127.80	–	–	
" cellulose, . . .	31.49	629.80	365.28	58	
" fat, ...	3.39	67.80	9.49	14	
" protein (nitrogenous matter), . .	13.71	274.20	175.49	64	
Non-nitrogenous extract matter, ...	45.06	901.20	549.73	61	
	100.00	2,000.00	1,099.99	–	

Fodder Corn (Green).

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	71.86	1,437.20	–	–	1 : 11.19
Dry matter,	28.14	562.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	3.78	75.60	–	–	
" cellulose,	25.67	513.40	369.65	72	
" fat,	2.24	44.80	33.60	75	
" protein (nitrogenous matter),	7.62	152.40	114.30	75	
Non-nitrogenous extract matter,	60.69	1,213.80	825.38	68	
	100.00	2,000.00	1,342.93	–	

4. Creamery Record of the Station for the Years 1890 and 1891.

The cost of feed consumed is based on the market price of the various ingredients, as is stated in the subsequent table.

The valuation of the whole milk is taken at three cents per quart. The estimates of the value of fertilizing ingredients contained in the feed are based on those given in the following table.

The local market value and the value of the essential fertilizing constituents of the fodder articles used are reckoned for the year 1890, in order to render the results comparable.

Local Market Value per Ton of the Various Articles of Fodder used.

Corn meal,	$23 00
Wheat bran,	21 50
Gluten meal,	23 00
Brewers' grain,	22 00

Local Market Value per Ton, etc. — Concluded.

New-process linseed meal,	$26 00
Old-process linseed meal,	27 00
Cotton-seed meal,	26 00
Hay,	15 00
Rowen,	15 00
Corn fodder,	5 00
Corn stover,	5 00
Corn ensilage,	2 25
Corn and soja bean ensilage,	3 50
Soja bean (green),	4 40
Vetch and oats (green),	2 75
Fodder corn (green),	2 50
Carrots,	7 00
Sugar beets,	5 00
Cabbages,	2 50

Valuation of the Essential Fertilizing Constituents of the Various Articles of Fodder used.

Nitrogen, 16½ cents; phosphoric acid, 6 cents; potassium oxide, 4½ cents per pound.

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per Ton.
Corn meal,	1.86	0.77	0.45	$7 44
Wheat bran,	2.82	3.05	1.49	14 24
Gluten meal,	5.22	0.40	0.05	17 75
Brewers' grain,	3.299	1.192	1.466	13 56
New-process linseed meal,	6.25	1.42	1.16	23 32
Old-process linseed meal,	5.33	1.64	1.16	20 54
Cotton-seed meal,	6.467	2.33	1.723	25 60
Hay,	1.25	0.464	2.085	6 46
Rowen,	1.93	0.364	2.86	9 24
Corn fodder (dry),	1.37	0.368	0.355	5 26
Corn stover (dry),	0.78	0.09	0.599	3 19
Corn ensilage,	0.36	0.14	0.33	1 64
Corn and soja bean ensilage,	0.708	0.42	0.444	3 22
Soja bean (green),	0.590	0.193	0.311	2 44
Vetch and oats (green),	0.23	0.09	0.79	1 54
Fodder corn (green),	0.343	0.195	0.43	1 73
Carrots,	0.14	0.10	0.54	1 04
Sugar beets,	0.29	0.03	0.18	1 15
Cabbages,	0.300	0.11	0.43	1 48

The value of cream is that granted us from month to month by our local creamery association. The station has no other connection with the financial management of the creamery.

Our presentation of financial results is based on the local cost of feed alone, and does not consider interest on investment and labor involved, for the reason that approximate estimates on these points are in an exceptional degree dependent on quality of stock and varying local circumstances. The details are embodied in a few subsequent tables under the following headings: —

1. Statement of articles of fodder used.
2. Record of average quality of milk and of fodder rations.
3. Value of cream produced at creamery basis of valuation.
4. Cost of skim-milk at the selling price of three cents per quart of whole milk.
5. Fertilizing constituents of cream.
6. Some conclusions suggested by the records.
7. Analyses of cream, and modes of analysis of milk, cream and butter.

Statement of Articles of Fodder used during 1890 (in Pounds).

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	New-process Linseed Meal.	Cotton-seed Meal.	Hay.	Rowen.	Fodder Corn.	Corn Stover.	Corn Ensilage.	Vetch and Oats.	Soja Beans.	Carrots.	Sugar Beets.
January,	604.50	604.50	-	604.50	-	-	1,016.00	-	-	-	7,737.50	-	-	-	-
February,	370.50	546.00	-	529.75	-	-	514.00	-	850.50	-	4,687.50	-	-	1,080.00	-
March,	-	604.50	-	604.50	-	-	-	-	1,132.00	1,665.00	-		-	3,680.00	-
April,	184.50	577.50	-	106.50	444.00	-	977.00	-	1,201.50	472.50	-	-	-	2,520.00	1,080.00
May,	604.50	604.50	-	340.50	262.50	-	2,656.50	360.00	-	-	-	-	-	-	3,240.00
June,	585.00	585.00	-	379.50	204.00	-	-	3,723.50	-	-	-	-	-	-	-
July,	604.50	604.50	-	-	604.50	-	725.50	613.00	-	-	-	7,463.00	-	-	-
August,	604.50	604.50	-	-	604.50	-	930.00	-	-	-	-	910.50	8,882.50	-	-
September,	585.00	585.00	-	-	585.00	-	120.00	2,935.00	-	-	-	-	1,767.00	-	-
October,	571.50	571.50	-	-	223.50	348.00	-	3,221.50	-	-	-	-	-	-	
November,	450.00	450.00	120.00	-	-	330.00	-	3,555.50	-	-	-	-	-	-	-
December,	465.00	465.00	255.00	-	-	210.00	-	3,225.00	-	-	-	-	-	-	-

1. *Statement of Articles of Fodder used during 1891 (in Pounds).*

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Cotton-seed Meal.	Brewers' Grain.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Mixed Ensilage.	Vetch and Oats.	Soja Beans.	Sugar Beets.	Cabbages.
January,	541.50	541.50	–	244.50	297.00	–	–	2,355.00	–	–	1,614.00	–	–	840.00	–
February,	504.00	504.00	306.00	–	198.00	–	–	857.00	–	–	7,566.00	–	–	–	–
March,	558.00	558.00	450.00	–	108.00	–	–	169.00	–	2,153.50	1,269.00	–	–	–	–
April,	537.00	540.00	–	–	534.00	–	–	1,915.50	–	106.50	–	–	–	–	–
May,	558.00	558.00	450.00	–	108.00	–	–	3,295.00	–	–	–	–	–	–	–
June,	516.00	540.00	516.00	–	–	–	–	2,417.50	–	–	–	–	–	–	–
July,	555.00	180.00	555.00	–	–	378.00	–	1,052.00	–	–	–	7,285.00	–	–	–
August,	558.00	324.00	558.00	–	–	234.00	–	1,032.50	–	–	–	479.00	6,965.00	–	1,820.00
September,	540.00	–	540.00	–	–	540.00	–	690.00	4,504.50	–	–	–	1,011.00	–	1,800.00
October,	558.00	–	222.00	–	–	558.00	2,673.00	–	–	–	–	–	–	680.00	1,560.00

Record of Average Quality of Milk and of Fodder Rations (1890).

1890.	Average Percentage of Solids in Milk.	Average Percentage of Fat in Milk.	Quarts of Milk required to make one Space of Cream.	Nutritive Ratio of Feed.	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	New-process Linseed Meal.	Cotton-seed Meal.	Hay.	Rowen.	Fodder Corn.	Corn Stover.	Corn Ensilage.	Vetch and Oats.	Soja Bean.	Carrots.	Sugar Beets.
					Feed consumed per Day (in Pounds).														
January, .	14.18	4.72	1.45	1 : 6.25	3.25	3.25	–	3.25	–	–	5.00	–	–	–	44.74	–	–	–	–
February, .	14.02	4.64	1.51	1 : 6.25	3.25	3.25	–	3.25	–	–	5.00	–	–	–	44.74	–	–	–	–
				1 : 5.14	–	3.25	–	3.25	–	–	–	–	13.74	–	–	–	–	20.00	–
March, .	14.21	4.99	1.57	1 : 5.14	–	3.25	–	3.25	–	–	–	–	13.74	–	–	–	–	20.00	–
				1 : 5.14	–	3.25	–	3.25	–	–	–	–	–	16.00	–	–	–	20.00	–
April, .	13.37	4.42	1.66	1 : 4.95	–	3.25	–	–	3.25	–	–	–	16.13	–	–	–	–	20.00	–
				1 : 5.22	3.25	3.25	–	–	3.25	–	15.90	–	–	–	–	–	–	–	20.00
May, . .	13.73	4.38	1.75	1 : 5.22	3.25	3.25	–	–	3.25	–	15.90	–	–	–	–	–	–	–	20.00
				1 : 5.60	3.25	3.25	–	3.25	–	–	15.67	–	–	–	–	–	–	–	20.00
June, . .	13.42	4.39	1.76	1 : 5.04	3.25	3.25	–	3.25	–	–	–	20.60	–	–	–	–	–	–	–
				1 : 4.73	3.25	3.25	–	–	3.25	–	–	20.75	–	–	–	–	–	–	–
July, . .	13.91	4.45	1.67	1 : 5.96	3.25	3.25	–	–	3.25	–	5.00	–	–	–	–	53.75	–	–	–
August, .	14.65	4.95	1.61	1 : 4.69	3.25	3.25	–	–	3.25	–	5.00	–	–	–	–	–	55.00	–	–
September,	13.47	4.57	1.59	1 : 4.91	3.25	3.25	–	–	3.25	–	–	19.86	–	–	–	–	–	–	–
October, .	13.84	4.82	1.56	1 : 4.91	3.25	3.25	–	–	3.25	–	–	19.86	–	–	–	–	–	–	–
				1 : 4.84	3.00	3.00	–	–	–	3.00	–	19.25	–	–	–	–	–	–	–
November,	14.24	5.02	1.57	1 : 4.60	3.00	3.00	–	–	–	3.00	–	20.00	–	–	–	–	–	–	–
December, .	14.80	5.09	1.61	1 : 5.13	3.00	3.00	3.00	–	–	–	–	18.00	–	–	–	–	–	–	–
				1 : 4.83	3.00	3.00	–	–	–	3.00	–	18.00	–	–	–	–	–	–	–
Averages,	13.99	4.70	1.61	1 ; 5.19															

2. *Record of Average Quality of Milk and of Fodder Rations (1891).*

1891.	Average Percentage of Solids in Milk.	Average Percentage of Fat in Milk.	Quarts of Milk required to make One Space of Cream.	Nutritive Ratio of Feed.	Feed consumed (Pounds) per Day.												
					Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Cotton-seed Meal.	Brewers' Grain.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn and Soja Bean Ensilage.	Vetch and Oats.	Soja Beans.
January, . .	14.99	5.19	1.54	1 : 4.83	3.00	3.00	–	3.00	–	–	–	18.00	–	–	–	–	–
				1 : 4.17	3.00	3.00	–	–	3.00	–	–	5.00	–	–	42.00	–	–
February, . .	14.71	5.09	1.76	1 : 4.17	3.00	3.00	–	–	3.00	–	–	5.00	–	–	42.00	–	–
				1 : 4.70	3.00	3.00	3 00	–	–	–	–	5.00	–	–	46.00	–	–
March, . .	14.82	5.00	1.62	1 : 6.74	3.00	3.00	3.00	–	–	–	–	–	–	14.00	–	–	–
April, . .	14.41	5.21	1.53	1 : 5.66	3.00	3.00	–	–	3.00	–	–	–	–	14.00	–	–	–
				1 : 4.49	3.00	3.00	–	–	3.00	–	–	18.00	–	–	–	–	–
May, . . .	13.75	4.39	1.67	1 : 5.14	3.00	3.00	3.00	–	–	–	–	18.00	–	–	–	–	–
June, . .	–	–	1.76	–	–	–	–	–	–	–	–	–	–	–	–	–	–
July, . . .	13.41	4.18	1.78	1 : 6.17	3.00	–	3.00	–	–	3.00	–	5.00	–	–	–	47.00	–
August, . .	13.42	4.22	1.86	1 : 5.07	3.00	3.00	3.00	–	–	3.00	–	5 00	–	–	–	–	51 00
				1 : 4.76	3.00	–	3.00	–	–	–	–	5.00	–	–	–	–	47.00
September, .	13.90	4.15	1.75	1 : 6.17	3.00	–	3.00	–	–	3.00	–	5 00	39.00	–	–	–	–
October, . .	–	–	1.72	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Averages, .	14.18	4.68	1.70	1 : 5.17													

3. *Value of Cream at Creamery Basis of Valuation.*

	Total Cost of Feed consumed.	Total Value of Fertilizing Constituents of Food consumed.	Value of Fertilizing Constituents lost in Cream.	Net Cost of Feed for Production of Cream.	Value of Cream produced.
1890.					
January,	$37 78	$23 07	$0 64	$15 35	$33 99
February,	32 19	19 62	0 69	13 26	36 93
March,	34 38	19 75	0 66	15 29	37 52
April,	38 54	19 75	0 68	19 47	32 40
May,	52 09	25 32	0 73	27 50	33 45
June,	48 63	30 05	0 72	19 30	30 66
July,	41 65	23 90	0 68	18 43	29 04
August,	49 09	27 52	0 73	22 30	39 27
September,	47 43	28 68	0 72	19 47	42 05
October,	44 48	27 82	0 65	17 31	39 92
November,	42 36	26 59	0 58	16 35	34 83
December,	40 20	24 89	0 54	15 85	32 84
Averages,	$42 40	$24 75	$0 67	$18 32	$35 24
1891.					
January,	$41 79	$26 14	$0 60	$16 25	$35 23
February,	36 98	26 85	0 61	10 74	25 49
March,	27 86	17 66	0 69	10 89	42 44
April,	35 96	23 22	0 63	13 37	37 36
May,	43 70	26 64	0 74	17 80	40 82
June,	35 80	21 51	0 68	14 97	32 40
July,	36 76	21 30	0 66	16 12	32 26
August,	44 88	25 92	0 68	19 64	36 26
September,	33 64	20 11	0 68	14 21	41 84
October,	43 18	22 30	0 63	21 51	39 48
Averages,	$38 06	$23 17	$0 66	$15 55	$37 36

4. *Cost of Skim Milk at the Selling Price of Three Cents per Quart for Whole Milk.*

	Quarts of Milk produced.	Spaces of Cream.	Quarts of Cream (One Quart equals 3.4 Spaces).	Quarts of Skim-milk.	Value of Cream per Space (Cents).	Value of Cream per Quart of Milk (Cents).	Total Value of Cream.	Cost of Skim-milk per Quart (Whole Milk at Three Cents per Quart).	Total Cost of Skim-milk.
1890.								Cents.	
January, .	1,404.1	971	285.6	1,118.5	3.50	2.42	$33 99	0.73	$8 13
February, .	1,596.2	1,055	310.3	1,285.9	3.50	2.31	36 93	0.85	10 96
March, . .	1,594.8	1,014	298.2	1,296.6	3.70	2.35	37 52	0.80	10 32
April, . .	1,720.8	1,035	304.4	1,416.4	3.13	1.88	32 40	1.36	19 22
May, . .	1,946.7	1,115	327.9	1,618.8	3.00	1.72	33 45	1.54	24 95
June, . .	1,922.4	1,095	322.1	1,600.3	2.80	1.59	30 66	1.69	27 01
July, . .	1,727.0	1,037	305.0	1,422.0	2.80	1.68	29 04	1.60	22 77
August, . .	1,809.5	1,122	330.0	1,479.5	3.50	2.17	39 27	1.02	15 02
September, .	1,747.4	1,098	322.9	1,424.5	3.83	2.41	42 05	0.73	10 37
October, .	1,556.9	998	293.5	1,263.4	4.00	2.56	39 92	0.54	6 79
November, .	1,413.5	893	262.6	1,150.9	3.90	2.46	34 83	0.66	7 57
December, .	1,321.6	821	241.5	1,080.1	4.00	2.48	32 84	0.61	6 81
Averages, .	1,646.7	1,021	300.3	1,346.4	3.47	2.17	$35 24	1.01	$14 16
1891.									
January, .	1,413.5	915	269.1	1,144.4	3.85	2.49	$35 23	0.63	$7 18
February, .	1,643.8	934	274.7	1,369.1	3.80	2.16	35 49	1.01	13 82
March, . .	1,700.2	1,048	308.2	1,392.0	4.05	2.50	42 44	0.62	8 57
April, . .	1,468.1	958	281.8	1,186.3	3.90	2.54	37 36	0.56	6 68
May, . .	1,889.7	1,134	333.2	1,556.5	3.60	2.16	40 82	1.02	15 87
June, . .	1,841.3	1,045	307.4	1,533.9	3.10	1.76	32 40	1.49	22 84
July, . .	1,791.2	1,008	296.5	1,494.7	3.20	1.80	32 26	1.44	21 48
August, . .	1,924.0	1,036	304.7	1,619.3	3.50	1.88	36 26	1.33	21 46
September, .	1,826.9	1,046	307.8	1,519.1	4.00	2.29	41 84	0.85	12 97
October, .	1,659.9	963	283.2	1,376.7	4.10	2.38	39 48	0.75	10 32
Averages, .	1,715.9	1,009	296.7	1,419.2	3.71	2.20	$37 36	0.97	$14 12

5. *Fertilizing Constituents of Cream.*

[Average analysis.]

	Per Cent.
Moisture at 100° C., ...	75.22
Nitrogen (16½ cents per pound), ...	.54
Potassium oxide (4¼ cents per pound), ...	.123
Phosphoric acid (6 cents per pound), ...	.168

6. *Conclusions.*

1. The nutritive ratio of the feed varied in 1890 from 1 : 4.60 to 1 : 6.25, with an average of 1 : 5.19 ; in 1891 from 1 : 4.17 to 1 : 6.74, with an average of 1 : 5.17.

2. The amount of fat in the milk varied in 1890 from 4.38 per cent. to 5.09 per cent., with an average of 4.70 per cent. ; in 1891 it varied from 4.15 per cent. to 5.21 per cent., with an average of 4.68 per cent.

3. The percentage of total solids varied in 1890 from 13.37 to 14.80 ; in 1891 from 13.41 to 14.99, with an average for 1890 of 13.99 and for 1891 of 14.18.

4. The total cost of feed for one quart of cream amounts in 1890 to 14.12 cents, and in 1891 to 12.83 cents.

5. The net cost of feed for one quart of cream amounts in 1890 to 6.10 cents, and in 1891 to 5.24 cents.

6. The value received for one space of cream varied in 1890 from 3 to 4 cents, with an average of 3.47 cents ; in 1891 from 3.10 to 4.10 cents, with an average of 3.71 cents, which amounts per quart (average) in 1890 to 11.80 cents and in 1891 to 12.61 cents.

7. The number of quarts of milk required to produce one space of cream in 1890 was 1.61, and in 1891, 1.70, or 5.47 quarts of whole milk to produce one quart of cream in 1890 and 5.78 quarts to produce one quart of cream in 1891.

8. The net cost of feed per quart of cream averages in 1890, 6.10 cents and in 1891, 5.24 cents. We received per quart of cream in 1890, 11.80 cents and in 1891, 12.61 cents, thereby securing a profit of 5.70 cents per quart in 1890 and 7.37 cents in 1891.

From these statements it appears, as has already been claimed in previous reports, that close fodder rations tend to improve the quality of the milk as well as the condition of the animal. The introduction of dried brewers' grain and cotton-seed meal into the daily diet has apparently lowered to a considerable extent the net cost of feed.

For further details concerning results in preceding years, see seventh annual report, pages 82 to 84, and also eighth annual report, pages 54 to 65.

Our average statements for the current year apply in each case to only ten months, due to the fact that financial settlement with our local creamery is made two months after cream is furnished.

7. Creamery Record, 1891. — Analyses of Cream and Butter Fat.

DATE OF SAMPLING.	ANALYSIS OF CREAM.			ANALYSIS OF FAT.		AVERAGE DAILY FODDER RATIONS.
	Solids.	Fat.	Solids not Fat.	Volatile Acids.	Non-volatile Acids.	
1891.						
Jan. 20, .	27.14	18.54	8.60	7.54	84.49	3 pounds corn meal, 3 pounds wheat bran, 3 pounds cotton-seed meal, 10 pounds rowen, 16 pounds mixed ensilage (corn and soja beans).
" 30, .	29.35	19.60	9.75	6.72	86.98	
Feb. 3, .	27.57	18.60	8.97	6.78	86.48	3 pounds corn meal, 3 pounds wheat bran, 3 pounds cotton-seed meal, 5 pounds rowen, 45 pounds mixed ensilage.
" 10, .	27.53	19.17	8.36	7.43	86.25	
Feb. 17, .	28.26	19.88	8.38	7.49	86.30	3 pounds corn meal, 3 pounds wheat bran, 3 pounds gluten meal, 5 pounds rowen, 50 pounds mixed ensilage.
" 24, .	27.41	20.76	6.65	7.32	86.10	
March 3, .	27.29	19.34	7.95	–	–	
March 11, .	26.82	18.98	7.84	–	–	3 pounds corn meal, 3 pounds wheat bran, 3 pounds gluten meal, 15 pounds corn stover.
" 17, .	26.53	18.63	7.90	–	–	
" 24, .	24.65	16.73	9.92	–	–	
March 31, .	24.74	17.53	7.21	6.14	88.89	3 pounds corn meal, 3 pounds wheat bran, 3 pounds cotton-seed meal, 15 pounds corn stover.
April 7, .	26.63	18.58	8.05	6.24	87.89	
" 13, .	26.75	18.84	7.91	6.52	88.32	
April 21, .	25.95	18.09	6.86	–	–	3 pounds corn meal, 3 pounds wheat bran, 3 pounds cotton-seed meal, 20 pounds rowen.
" 28, .	26.61	18.98	7.63	–	–	
May 5, .	27.36	19.56	7.80	–	–	
May 12, .	26.32	18.63	7.69	–	–	3 pounds corn meal, 3 pounds wheat bran, 3 pounds gluten meal, 18 pounds rowen.
" 19, .	25.68	18.11	7.57	–	–	
" 26, .	28.01	20.09	7.92	–	–	
July 14, .	24.65	17.30	7.35	–	–	3 pounds corn meal, 3 pounds brewers' grain (dry), 3 pounds gluten meal, 5 pounds rowen, 45 pounds vetch and oats (green).
" 23, .	24.27	16.45	7.82	–	–	
Aug. 11, .	25.21	18.12	7.09	–	–	3 pounds corn meal, 3 pounds wheat bran, 3 pounds gluten meal, 5 pounds rowen, 42 pounds soja beans (green).
" 18, .	25.93	18.41	7.52	–	–	

Creamery Record, 1891.—Analyses of Cream of Butter.

DATE OF SAMPLING.	Solids.	Fat.	Solids not Fat.	AVERAGE DAILY FODDER RATIONS.
1891.				
Aug. 25, .	27.44	19.27	8.17	3 pounds corn meal, 3 pounds brewers' grain (dry), 3 pounds gluten meal, 5 pounds rowen, 42 pounds soja beans (green).
Sept. 1, .	25.52	18.15	7.37	
Sept. 15, .	23.01	15.69	7.32	3 pounds corn meal, 3 pounds brewers' grain, 3 pounds gluten meal, 5 pounds rowen, 35 pounds fodder corn (green).
" 22, .	25.18	17.56	7.62	
Dec. 8, .	22.15	15.67	6.48	3 pounds maize feed, 3 pounds cotton-seed meal, 3 pounds wheat bran, 16 pounds sweet corn stover.
" 15, .	25.03	18.14	6.89	
" 22, .	24.33	17.71	6.62	
Dec. 29, .	25.97	18.66	7.31	3 pounds maize feed, 3 pounds cotton-seed meal, 3 pounds wheat bran, 14 pounds dent corn stover.

Method of Milk Analysis.

Total Solids.—Evaporate a known quantity of milk (approximately 5 grams) in a weighed porcelain dish, containing 15 to 20 grams of pure, dry sand, on the water bath until apparently dry, then transfer to the air bath and dry at 100° to 105° C. to a constant weight, weighing at intervals of about an hour. In case of cream, use 2.5 to 3 grams for evaporation.

Fat.—Pulverize the sand containing the solids without removing from the dish, subsequently transfer to a filter, and exhaust with anhydrous, alcohol-free ether. Dry the fat obtained on the evaporation of the ether in an air bath at 100° to 105° C. to a constant weight.

Ash.—A weighed quantity of milk is evaporated to dryness with a few drops of nitric acid, and burned in a muffle at a low red heat until free from carbon.

Methods of Butter Analysis.

(1) *Moisture.*—Two and five-tenths to 3 grams are dried at 100° C. in an air bath.

(2) *Salt.*—Six to 7 grams of the butter are washed into a separatory funnel with hot water, and are well shaken, and

allowed to stand until the fat has collected on top; the water is then drawn off, and a fresh quantity added, and shaken up with the butter. This is continued until 200 to 300 cubic centimetres of water have passed through the funnel. The washings are mixed, and made up to 500 cubic centimetres, and the chlorine determined in an aliquot part by means of silver nitrate. From the chlorine the salt is readily calculated.

(3) *Fat.* — Two and five-tenths to 3 grams of the fat freed from salt by the above operation (2), and from water by drying in the air bath, are dissolved in ether, and filtered from the curd into a tared flask. The ether is driven off, and the residual fat dried and weighed. In calculating the per cent., allowance is made for salt and water removed.

(4) *Casein.* — The residue remaining on the filter in (3) is tested for nitrogen by the Kjeldahl method. The factor 6.33 is used in reducing the per cent. of nitrogen found to casein.

Method for determining Volatile and Non-volatile Fatty Acids contained in Butter.

The sample is prepared by churning the cream in a suitable bottle, washing the butter well with cold water, melting at 50 ° C. and filtering from the curd through a hot-water funnel. The fat is then heated in the air bath until free from water.

The method pursued in the determination of the volatile and non-volatile fatty acids is essentially that described by L. F. Nilson, in "Zeit. f. Anal. Chemie," 28, 2, 176.

Two and eight-tenths cubic centimetres to 2.9 cubic centimetres (approximately 2.5 grams) are measured into a tared Erlenmeyer flask of 250 cubic centimetres capacity, and the exact weight determined. Saponification is accomplished by adding 1 gram of potassium hydrate dissolved in 2 cubic centimetres of water, and 5 cubic centimetres of strong (95 per cent.) alcohol. The flask is provided with a reflux condenser, and heated until saponification is complete. The alcohol is then driven off, the last traces being removed by means of the following device: the flask is provided with a double perforated rubber cork, one hole carrying a glass tube reaching nearly to the bottom of the flask and provided above with a short rubber tube carrying a pinch-cock, the other connected by means of a rubber tube with a suction pump. By alternately opening and closing the pinch-cock while the pump is working, the last traces of alcohol can be readily removed from the soap.

Dissolve the soap thus obtained in 30 cubic centimetres of warm water, decompose with 20 cubic centimetres of a 20 per cent. solution of orthophosphoric acid, distil off the volatile acids through a condenser, filtering the distillate, and titrate with decinormal sodium hydrate, using phenolphthalein as indicator. The volatile acids are expelled from the flask by a current of steam. When the distillate amounts to 500 cubic centimetres, the operation is considered to be complete. The volatile acids are calculated as butyric.

The condenser and connections are rinsed back into the flask with boiling water, and the non-volatile acids washed with hot water, and filtered when cool through the same filter that was used for the distillate. The washing is continued until no traces of phosphoric acid are left in the distillate. The filter is then exhausted with hot alcohol, allowing the solution to run into the flask. The alcohol is driven off on the water bath, and the non-volatile fatty acids dried at 100° C. in the air bath until they begin to gain weight.

5. *Some General Remarks on Analysis of Fodder and Fodder Analyses.*

The application of an intelligently devised system of chemical tests, for the purpose of ascertaining the amount and the relative proportions of the essential proximate constituents of our fodder articles, has rendered valuable services to practical agriculture. The chemical analysis of plants during their successive stages of growth has shown marked alterations in their composition, as far as the *absolute amount* of vegetable matter, as well as the *relative proportion* of the essential plant constituents, are concerned. It has rendered not less conspicuous the important influence which the soil in its varying state of fertility exerts on the quantity and the quality of the growth raised upon it. The lessons derived from this source of information have stimulated inquiries concerning the safest modes of manuring, of cultivating and of harvesting our different farm crops with the prospect of securing the most satisfactory returns under existing circumstances.

A better knowledge regarding the particular quality of the various articles of fodder at our disposal improves our chances of supplementing them judiciously and thus economically for different kinds of farm live-stock, as well as for different conditions and functions of the same kind. It furnishes, also, a safer basis for the explanation of the results obtained in actual feeding experiments. To study the nutritive value or feeding effect of any of our fodder articles by actual feeding experiments, without learning, as far as practicable, something more definite regarding its peculiar quality or composition, deprives the results obtained largely of their general interest, for they are secured under ill-defined circumstances. The chemical analysis of an article of fodder is for these reasons considered the first step required to render an intelligent interpretation of the results in feeding trials possible.

Food Constituents. — Actual feeding experiments have shown that *three groups of plant constituents*, namely, *nitrogenous*, *non-nitrogenous* and *mineral constituents*, are *needed* to successfully sustain animal life. No one or two of them, alone, can support it for any length of time. In case the food does not contain digestible non-nitrogenous substances, the fat and a portion of the muscles of the animal on trial will be consumed in the support of respiration before its life terminates. In case digestible nitrogenous constituents are excluded from the diet, the formation of new blood and flesh from the food consumed ceases; for the animal system, according to our present state of information, is not capable of producing its principal constituents from anything else than the nitrogenous constituents of the plants.

Herbivorous animals receive these substances directly from the plants; carnivorous animals indirectly, by feeding on herbivorous animals. We feed, at present, our farm-stock too frequently, without a due consideration of the general natural law of nutrition; to deal out our fodder crops only with mere reference to name, instead of making ourselves more familiar with their composition and their particular quality, deprives us even of the chance of drawing an intelligent conclusion from our present system of feeding.

To compound the animal diet with reference to the particular organization of the animal, its age and its functions, is of no more importance than to select the fodder substances with reference to its special wants, as far as the absolute and relative quantity of the three essential groups of food constituents are concerned.

The peculiar character of our home-raised fodder articles is apt to conceal their special deficiency for the various purposes they are used for in general farm management. They all contain the three essential food constituents, yet in widely varying proportions; and they ought, therefore, to be supplemented in different directions to secure their full economical value. To resort to more or less of the same fodder article to meet the special wants may meet the case as far as an efficient support of the animal is concerned, yet it can only in exceptional cases be considered good economy.

Fodder Rations. — To satisfy the craving of the stomach and to feed a nutritious food are both requirements of a healthy animal diet, which, each in its own way, may be complied with. The commercial fodder substances — as oil-cakes, mill refuse brans, and our steadily increasing supply of refuse materials from breweries, starch works, glucose factories, etc. — are admirably fitted to supplement our farm resources for stock feeding; they can serve in regard to animal growth and support, in a similar way as the commercial fertilizers in the growth of our farm crops, by supplementing our home manurial resources. To feed an excess of food materials, as roots, potatoes, etc., which contain a large proportion of non-nitrogenous matter, as starch, sugar, digestible cellular substance, etc., means direct waste, for they are ejected by the animal, and do not even materially benefit the manure heap. In case of an excessive consumption of nitrogenous constituents, — as oil-cakes, brans, gluten meal, etc., — a part of the expense is saved in an increased value of the manure obtained, yet scarcely enough to recommend that practice beyond merely exceptional cases. The aim, therefore, of an economical stock-feeding must be to compound our various fodder materials in such a manner that the largest quantity of each of the three above-stated groups of fodder substances, which the animal is capable of assimilating, should be contained in its daily diet to meet the purpose for which it is kept.

To compound the fodder rations of our farm stock, with reference to the special wants of each class of them, is an essential requirement for a satisfactory performance of their functions; to supply these wants in an economical way controls the financial success of the industry. From these and similar considerations it will be apparent that the development of a more rational, and thus more economical, system of feeding farm live-stock requires the following kind of information: —

First. How much of each of the three essential groups of food constituents is contained in the fodder we feed?

Second. How much of each of these essential food constituents is digestible under existing circumstances, and is thus directly available to the particular animal on trial?

Third. How much of each of the three essential food constituents does each kind of animal require to secure the best results?

More than twenty-five years have passed by since these questions have seriously engaged the attention of skilful experimenters. Sufficient valuable information has been secured in the course of time to encourage the use of the adopted methods of observation, and to impart to many of the conclusions arrived at a just claim for a serious consideration on the part of practical agriculturists. The fact that much needs still to be learned to meet the reasonable expectations of those engaged in the development of a more economical system of feeding farm live-stock cannot be considered a valid reason why we should not make an intelligent use of what we have learned.

Fodder Analysis. — The chemical analysis of a fodder article is carried on with a view to determine the quantity of each group of its constituents, which is considered an essential ingredient of a complete food for the support of animal life. Our modes of analyzing articles of fodder are practically the same, wherever this work is carried out intelligently. The results obtained are, therefore, applicable for the determining of a comparative value wherever the identity of the material can be established.

The actual results of the analysis are usually reported under the following headings: —

1. Amount of moisture lost at 110° C., or 230° F., and amount of dry matter left behind.
2. Amount of mineral matter left behind after a careful incineration of the material.
3. Amount of organic nitrogenous matter, commonly called crude protein.
4. Amount of non-nitrogenous organic matter, exclusive of fat and of coarse cellulose substances.

The entire mass which any fodder substance leaves behind after being heated at one hundred and ten degrees, Centigrade thermometer, is called dry matter. An increase in dry substance in case of any plant or part of plant at the same stage of growth indicates usually a higher feeding value. To satisfy the cravings of the animal, a certain quantity or bulk of coarse, dry matter becomes an important consideration in making up the fodder rations for different classes of animals. In raising young stock for fattening purposes, a liberal supply is also desirable, to effect a proper distension of the digestive organs, to make them good feeders hereafter.

Nitrogenous substances, or protein matter, refer to several groups of nitrogen-containing compounds, of plants in particular, as albumin, fibrin, legumin, basein, etc., which are essential for the formation of blood and tissues. Those contained in animal matter, as meat refuse, are frequently considered of a higher value than those in many plants.

Non-nitrogenous substances include, in particular, starch, sugars, organic acids, gums, fats and the digestible portion of the cellular matter of the fodder. These substances are readily transformed within the digestive organs into soluble compounds of a similar chemical character, and are thus assumed to serve an identical physiological purpose. As more recent investigations have shown a superior physiological value of fat, — one of the non-nitrogenous constituents, — two and one-half times as much as starch, sugar, and other representatives of that group, its amount is separately recorded. The same course, for similar reasons, has of late been adopted with reference to certain forms of nitrogenous organic constituents of fodder articles.

Fatty substances include all the various natural fats of the plant. Most plants contain more than was assumed at an earlier stage of inquiry. As the fat is separated by means of ether, the statements in the analyses do not exactly express the amount of fatty matter alone, but include more or less resinous substances, wax, etc., which are largely soluble in ether, and of a similar highly carbonaceous character. The fat of the fodder seems to serve, in case of judicious fodder rations, mainly to increase the stock of fat in the animal which consumes the fodder.

Digestibility of Fodder. — Wherever the article has been tested by actual feeding experiment under skilful observation, the amount of each essential group of food constituents which has been shown to be digestible is reported in connection with the chemical analysis, under the heading *Digestible Portion*, per hundred weight or per ton. The higher or lower degree of digestibility of a fodder article exerts a decided influence on its nutritive value. Different stages of growth affect the rates of digestibility of the various plant constituents. The same feature is noticed in regard to different parts of plants, as well as in case of different kinds of animals.

More than two hundred fodder articles have thus far been studied under varying circumstances, and most of our current kinds of fodders have been tested in Europe and elsewhere, in numerous well-conducted feeding experiments with a suitable selection of different kinds of farm live-stock. This fact imparts to many of the results recorded a sufficient importance to recommend them as a basis of new feeding trials, with feed stuffs raised in our climate, or obtained in our home industries.

Nutritive Ratio. — The last, but not least important, column of the statement of the chemical analysis — quite frequently found in the general record of a fodder for a practical agricultural purpose — is that of "Nutritive Ratio." These words are used to express the numerical relation of its *digestible nitrogenous substances* taken as one, as compared with the sum of its *digestible non-nitrogenous organic substances*, fat included. The information derived from that statement is very important; for it means to express the summary of results secured by actual feeding trials under specified conditions, and with the aid of the best endorsed chemical modes to account for the constituents of the food before and after it has served for the support of the animal on trial.

Experience has shown that different kinds of animals, as well as the same kind at different ages and for different functions, require a different proportion of the essential groups of food constituents to produce in each case the best results. A statement of the nutritive ratio of a fodder article — otherwise well adapted as an ingredient of a daily diet in the case under consideration — indicates the direction in which the material has to be supplemented to economize to a full extent its various constituents.

Practical trials with milch cows have demonstrated that they require for the highest production of a good milk and the maintenance of a healthy live weight, the most nutritious food we are in the habit of giving to full-grown farm animals. Careful examinations into the composition of an efficient diet for milch cows have shown that it contains one part of digestible nitrogenous matter to from five to five and a half parts of digestible non-nitrogenous organic matter. A due consideration of these facts renders it but natural that a good corn ensilage, which has a nutritive ratio of from 1 to 10 to 1 to 12, needs a liberal addition of substances like oil-cakes, wheat bran, gluten meal, etc., which have a nutritive ratio of 1 to from 2.5 to 4, to secure its full value as an ingredient of a daily diet in the dairy; or that good hay shows less the beneficial effects of an addition of these valuable waste products than that of an inferior quality. The nutritive ratio of hay may vary from 1 to 5.5 to from 1 to 9 or more.

Market Cost and Food Value. — *The value of an article of fodder may be stated from two different stand-points,* — that is, *with reference to its cost in the local market* and *with reference to its nutritive feeding value.* The *market price may be expressed by a definite sum for each locality; it depends on demand and supply in the market*, and it is beyond the control of the individual farmer. *The nutritive value*, or commonly called *food value*, *of the article cannot be expressed by a definite sum; it varies with a more or less judicious application*, and *depends also, to a considerable degree, on its adaptation under varying circumstances.* To secure the most satisfactory returns from feeding our home-raised fodder crops is as important a question as that of raising them in an economical manner. The great progress which has been made of late in regard to the proper mode of feeding plants ought to serve as an encouragement to undertake the task of inquiring more systemmatically into the proper mode of feeding our farm live-stock in the most profitable way.

Manurial Value of Fodder Articles. — Assuming a similar degree of adaptation of the various fodder articles offered for our choice, the question of cost deserves a serious consideration, when feeding for profit. *The actual cost of a fodder article does not depend merely upon its market price, but is materially affected by the value of the manurial refuse it leaves behind, when it has served its purpose as food.* The higher the percentage of nitrogen, phosphoric acid and potash a diet contains, the more valuable is the manure it furnishes, under otherwise corresponding circumstances. An excess, therefore, of any one or of all three in one diet, as compared with that of another, counts in favor of that particular diet as far as the net cost of feed is concerned; for it is admissible, for mere practical, economical purposes, to assume that, in raising one and the same kind of animals to a corresponding weight, or feeding them for the same purpose, a corresponding amount of nitrogen, phosphoric acid, potassium oxide, etc., will be retained, and, according to circumstances, either stored up in the growing animal or passed into the milk, etc. The commercial value of the three above-mentioned essential articles of plant food, contained in the manure secured in connection with our feeding experiments with milch cows, has differed in case of different diets from less than one-third to more than one-half of the market cost of feed consumed.

As the financial success in a mixed farm management depends, in a considerable degree, on the amount, the character and the money value of the manurial refuse material secured in connection with the special farm industry carried on, it needs no farther argument to prove that the relations which exist between the composition of the fodder and the value of the manure resulting deserve the careful consideration of the farmer when devising an efficient and, at the same time, an economical diet for his live-stock. To assist in a due consideration of this important circumstance a compilation of analyses of a great variety of fodder articles made in the course of years at the Massachusetts Experiment Station has been added to this report in the form of an appendix.

Valuation of Concentrated Commercial Feed Stuffs. — Most of our concentrated feed stuffs, as oil-cakes, brans, middlings, maize feed, gluten meals, starch feed, etc., are by-products of various branches of industry. The articles contain, as a rule, a more liberal amount of nitrogenous food constituents than the materials from which they are obtained, and they are usually bought for the purpose of raising the nitrogen-containing food constituents of the daily diet of our farm live-stock to a desired proportion. This general practice is based on the circumstance that the larger portion of our home-raised coarse fodder articles, as meadow hay, fodder corn, corn stover, corn ensilage, roots, etc., is, comparatively speaking, quite deficient in nitrogen-containing food constituents, to meet, in an economical way, the requirement of an efficient daily diet for dairy stock, hard-worked animals, young farm live-stock of various kinds, etc. The concentrated commercial feed stuffs, if judiciously selected and in a proper mechanical condition, are admirably adapted to add to our home-raised coarse fodder articles that food constituent in which they are deficient, without increasing in an objectionable degree the bulk or volume of the daily fodder ration. They tend thereby to increase, as a rule, materially, the nutritive value of our home-raised coarse fodder articles. Farmers that do not raise a liberal proportion of clover-like fodder plants are, in a particular degree, in need of concentrated commercial feed stuffs rich in nitrogenous food constituents to turn the excess of the non-nitrogenous food constituents, which most of our current home-raised coarse fodder articles contain, to the best possible account.

As we buy, in the majority of cases, the concentrated commercial feed stuffs on account of their large proportion of nitrogen-containing food constituents, it becomes of special interest to know at what cost a given quantity of digestible nitrogen-containing food constituents can be bought in the form of different feed stuffs equally well adapted under existing circumstances. A change in the market cost of one and the same commercial feed stuff affects the cost of the nitrogen-containing food constituent, in particular as its supply is more limited than that of the non-nitrogenous food constituents, which our home-raised coarse fodder articles contain, as a rule, in abundance.

The subsequent tabular statement assumes a constant cost of digestible non-nitrogenous food constituents, — sugar, starch, fat, etc., — and shows thereby the variations in the cost of digestible nitrogen-containing food constituents in case of some prominent concentrated commercial feed stuffs in our local market.

The majority of the analyses stated is made of fodder articles which have been used either during the past year in connection with some of our feeding experiments, or have been raised upon the grounds of the station. Some articles sent on by outside parties are added, on account of the special interest they may present to others.

Valuation of Fodder Articles on the following Basis.

Digestible cellulose and nitrogen free extract matter, 1.00 cent per pound; digestible fat. 2.50 cents per pound. The value of digestible protein determined the difference of the sum of both and the market cost of the fodder articles. (Calculation is based on dry matter, 2,000 pounds.)

	Market Cost.	Protein per Pound.
		Cents.
Corn meal,	$31 00	6.88
Corn meal,	29 00	5.84
Corn meal,	24 00	3.24
Corn meal,	23 00	2.72
Wheat middlings,	20 00	3.13
Spring wheat bran,	19 00	3.04
Winter wheat bran,	21 00	3.93
Chicago maize feed,	23 00	2.34
Dried brewers' grain,	22 00	3.37
Old-process linseed meal,	26 00	2.20
New-process linseed meal,	27 00	2.68
Chicago gluten meal,	28 00	2.46
Cotton-seed meal,	28 00	2.34
English hay,	12 00	1.36
English hay,	15 00	4.12
Rowen,	12 00	1.21
Rowen,	15 00	3.24
Corn stover,*	5 00	–
Corn ensilage,*	2 50	–
Mangold roots,*	3 00	–
Sugar beets,*	5 00	–

* The value of the digestible cellulose, nitrogen free extract matter and fat, on the above basis, exceeds the market cost.

	CORN MEAL.				WHEAT MIDDLINGS.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture,	15.31	–	–	1:9.23	10.07	–	–	1:4.54
Dry matter,	84.69	–	–		89.93	–	–	
	100.00	–	–		100.00	–	–	
Analysis of Dry Matter.								
Crude ash,	1.72	–	–		6.99	–	–	
" cellulose,	2.17	48	20.83		9.21	24	44.20	
" fat,	4.84	85	82.28		5.31	71	75.40	
" protein,	12.18	79	192.44		16.72	78	260.83	
N-free extract matter,	79.09	98	1,550.16		61.77	77	951.26	
	100.00	–	1,845.71		100.00	–	1,331.69	

	SPRING WHEAT BRAN.				WINTER WHEAT BRAN.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture,	12.74	–	–	1:4.48	13.06	–	–	1:4.36
Dry matter,	87.26	–	–		86.94	–	–	
	100.00	–	–		100.00	–	–	
Analysis of Dry Matter.								
Crude ash,	8.06	–	–		7.76	–	–	
" cellulose,	13.75	24	66.00		12.74	24	61.15	
" fat,	5.46	71	77.53		3.43	71	48.71	
" protein,	16.19	78	252.56		16.24	78	253.34	
N-free extract matter,	56.54	77	870.72		59.83	77	921.38	
	100.00	–	1,266.81		100.00	–	1,284.58	

	CHICAGO MAIZE FEED.				BREWERS' GRAIN.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture,	9.75	–	–	1 : 4.49	10.19	–	–	1 : 3.15
Dry matter,	90.25	–	–		89.81	–	–	
	100.00	–	–		100.00	–	–	
Analysis of Dry Matter.								
Crude ash,	0.75	–	–		2.98	–	–	
" cellulose,	9.65	62	119.66		8.07	40	64.56	
" fat,	6.15	85	104.55		5.25	83	87.15	
" protein,	21.33	79	337.01		22.76	74	336.85	
N-free extract matter,	62.12	91	1,130.58		60.94	64	780.03	
	100.00	–	1,691.80		100.00	–	1,268.59	

	OLD-PROCESS LINSEED MEAL.				NEW-PROCESS LINSEED MEAL.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture,	8.72	–	–	1 : 1.93	8.29	–	–	1 : 1.74
Dry matter,	91.28	–	–		91.71	–	–	
	100.00	–	–		100.00	–	–	
Analysis of Dry Matter.								
Crude ash,	5.96	–	–		5.91	–	–	
" cellulose,	8.23	26	42.79		9.43	26	49.04	
" fat,	9.87	91	179.63		4.08	91	74.26	
" protein,	36.19	87	629.70		35.03	87	609.51	
N-free extract matter,	39.75	91	723.45		45.55	91	829.01	
	100.00	–	1,575.57		100.00	–	1,561.82	

	Chicago Gluten Meal.				Cotton-seed Meal.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture,	11.11	–	–	1:2.66	9.77	–	–	1:1.37
Dry matter,	88.89	–	–		90.23	–	–	
	100.00	–	–		100.00	–	–	
Analysis of Dry Matter.								
Crude ash,	1.65	–	–		8.18	–	–	
" cellulose,	0.73	62	9.05		7.74	–	–	
" fat,	9.22	85	156.74		11.33	88	199.41	
" protein,	33.34	79	526.77		44.41	85	754.97	
N-free extract matter,	55.06	91	1,002.09		28.34	95	538.46	
	100.00	–	1,694.65		100.00	–	1,492.84	

	English Hay.				Rowen.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture,	9.72	–	–	1:9.68	13.53	–	–	1:6.93
Dry matter,	90.28	–	–		86.47	–	–	
	100 00	–	–		100.00	–	–	
Analysis of Dry Matter.								
Crude ash,	6.43	–	–		6.81	–	–	
" cellulose,	32.28	58	374.45		28.31	58	328.40	
" fat,	2.49	46	22.91		3.81	46	35.05	
" protein,	9.54	57	108.76		12.94	57	147.52	
N-free extract matter,	49.26	63	620.68		48.13	63	606.44	
	100.00	–	1,126.80		100.00	–	1,117.41	

	Corn Stover.				Corn Ensilage.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture,	22.50	–	–	1 : 8.62	72.95	–	–	1 : 11.67
Dry matter,	77.50	–	–		27.05	–	–	
	100.00	–	–		100.00	–	–	
Analysis of Dry Matter.								
Crude ash,	3.97	–	–		6.48	–	–	
" cellulose,	34.96	72	503.42		26.33	72	379.15	
" fat,	1.54	75	23.10		5.17	75	77.55	
" protein,	9.76	73	142.50		7.64	73	111.54	
N-free extract matter,	49.77	67	666.92		54.38	67	728.69	
	100.00	–	1,335.94		100.00	–	1,296.93	

	Mangold Roots.				Sugar Beets.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio
Moisture,	87.75	–	–	1 : 9.94	85.27	–	–	1 : 11.80
Dry matter,	12.25	–	–		14.73	–	–	
	100.00	–	–		100.00	–	–	
Analysis of Dry Matter.								
Crude ash,	9.06	–	–		5.95	–	–	
" cellulose,	7.94	100	158.80		6.49	100	129.80	
" fat,	0.88	100	17.60		0.66	100	13.20	
" protein,	10.37	100	207.40		10.97	100	219.40	
N-free extract matter,	71.75	100	1,435.00		75.93	100	1,518.60	
	100.00	–	1,818.80		100.00	–	1,881.00	

ANALYSES OF FODDER ARTICLES SENT ON BY FARMERS.

Corn Meal.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	13.52
Dry matter,	86.48
	100.00

Analysis of Dry Matter.

Crude ash,	2.34
“ cellulose,	2.47
“ fat,	4.85
“ protein (nitrogenous matter),	15.61
Non-nitrogenous extract matter,	74.73
	100.00

Corn and Cob Meal.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	19.11
Dry matter,	80.89
	100.00

Analysis of Dry Matter.

Crude ash,	2.05
“ cellulose,	6.97
“ fat,	3.46
“ protein (nitrogenous matter),	10.51
Non-nitrogenous extract matter,	77.01
	100.00
Passed screen 144 meshes to square inch,	73.88

Hominy Chop.

[Sent on from Southborough, Mass.]

	Per Cent.
Moisture at 100° C,	11.32
Dry matter,	88.68
	100.00

Analysis of Dry Matter.

Crude ash,	2.44
“ cellulose,	5.12
“ fat,	11.26
“ protein (nitrogenous matter),	6.77
Non-nitrogenous extract matter,	74.41
	100.00

Wheat Bran.

[Sent on from Amherst, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	10.47	13.17
Dry matter,	89.53	86.83
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	7.19	7.95
" cellulose,	11.27	11.22
" fat,	4.80	4.86
" protein (nitrogenous matter),	18.93	17.31
Non-nitrogenous extract matter,	57.81	58.66
	100.00	100.00

I. Wheat Bran (St. Louis).
II. Spring Wheat Bran (Duluth, Minn.).

[Sent on from Warren, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	10.12	8.97
Dry matter,	89.88	91.03
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	6.94	7.68
" cellulose,	9.72	10.84
" fat,	4.95	5.37
" protein (nitrogenous matter),	18.08	19.54
Non-nitrogenous extract matter,	60.31	56.57
	100.00	100.00

Ground Barley.

[Sent on from Amherst.]

	Per Cent.
Moisture at 100° C.,	14.62
Dry matter,	85.38
	100.00

Analysis of Dry Matter.

Crude ash,	3.18
" cellulose,	5.04
" fat,	2.38
" protein (nitrogenous matter),	14.93
Non-nitrogenous extract matter,	74.47
	100.00

Gluten Meal.

[From Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	10.90
Dry matter,	89.10
	100.00

Analysis of Dry Matter.

Crude ash,	1.02
" cellulose,	1.28
" fat,	7.36
" protein (nitrogenous matter),	34.79
Non-nitrogenous extract matter,	65.55
	100.00

Cotton-seed Meal.

[Sent on from Amherst, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C ,	9.07	9.06
Dry matter,	90.93	91.94
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	7.50	8.11
" cellulose,	6.81	8.69
" fat,	11.17	10.71
" protein (nitrogenous matter),	46.38	41.26
Non-nitrogenous extract matter,	28.14	31.23
	100.00	100.00

Cotton-seed Meal.

[I. sent on from Holden, Mass.; II. and III. sent on from Sunderland, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	8.90	8.50	9.37
Dry matter,	91.10	91.50	90.63
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	8.23	–	–
" cellulose,	7.15	–	–
" fat,	12.61	9.60	11.14
" protein (nitrogenous matter),	51.79	50.61	43.86
Non-nitrogenous extract matter,	20.22	–	–
	100.00	–	–

Cocoanut Meal.

[Sent on from Concord, Mass.]

	Per Cent.
Moisture at 100° C.,	9.33
Dry matter,	90.67
	100.00
Analysis of Dry Matter.	
Crude ash,	5.68
" cellulose,	18.80
" fat,	12.88
" protein (nitrogenous matter),	22.61
Non-nitrogenous extract matter,	40.03
	100.00

Hog Feed — Bakery Refuse.

[Sent on from North Hadley, Mass.]

	Per Cent.
Moisture at 100° C.,	13.34
Dry matter,	86.66
	100.00
Analysis of Dry Matter.	
Crude ash,	11.64
" cellulose,	0.43
" fat,	6.36
" protein (nitrogenous matter),	9.23
Non-nitrogenous extract matter,	72.34
	100.00

Hay from Salt Meadows.

[Sent on from Newbury, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	9.66	8.08	8.75
Dry matter,	90.34	91.92	91.25
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	5.01	5.03	9.03
" cellulose,	27.84	27.82	31.41
" fat,	2.65	3.24	3.37
" protein (nitrogenous matter),	4.35	3.77	6.72
Non-nitrogenous extract matter,	60.15	60.14	49.47
	100.00	100.00	100.00

Methods of Analysis of Cattle Foods.

1. Moisture. — Dry 2 grams in an air-bath at 100–110° C. to a constant weight.

2. Ash. — Char 2 to 5 grams in a muffle furnace at a low red heat, cool and weigh. Digest for a short time with dilute hydrochloric acid; collect the residue insoluble in acid in a Gooch crucible, wash, dry and weigh. Subtract this from the total weight for pure ash.

3. Ether Extract. — Dry 2 grams at 100° C. for two hours. Exhaust with anhydrous, alcohol-free ether, until the extraction is complete. Dry the extract in the air-bath at 100° C. to a constant weight.

4. Crude Protein. — Determine nitrogen by the Kjeldahl or soda-lime method, and multiply the result by 6.25 for crude protein.

5. Albuminoid Nitrogen. — Determine by Stutzer's method, as given in the " Proceedings of the Association of Official Agricultural Chemists," 1890 (pages 211 and 212), except that the protein-copper is dried before being introduced into the flask.

6. Crude Fibre or Cellulose. — The method is described in the " Proceedings of the Association of Official Agricultural Chemists," 1890 (page 212). In this method 2 grams of the material, having been nearly or completely freed from fat, are boiled for thirty minutes with 200 cubic centimetres of 1¼ per cent. sulphuric acid, brought upon a linen filter and thoroughly washed with boiling water. It is then washed into the boiling-flask with a 1¼ per cent. solution of sodium hydrate, brought quickly to 100° C., and boiled for thirty minutes, when it is filtered through a Gooch crucible, or balanced filter-papers, washed with boiling water, alcohol and ether, dried at 100° C. for an hour, and weighed. The organic matter is then burned off, and the weight of the ash deducted for crude cellulose.

II.

FEEDING EXPERIMENTS WITH STEERS.

The question of a remunerative production of beef for the meat market, upon the farms of New England, has, for several years past, received a deserved attention at the Massachusetts State Agricultural Experiment Station, by carrying on feeding experiments, under well-defined circumstances, with growing steers. The results of observations in that direction during two preceding years are ready for publication. The work is to be continued with such modifications as suggest themselves during its progress, and the conclusions arrived at will be published hereafter, whenever they are found to be of a more general interest to the farming community.

The first experiment, December, 1889, to May, 1890, briefly described upon a few succeeding pages, was planned mainly with a view to determine *the cost of the feed* required for the production of beef for the meat market under existing local conditions, and with special reference to the contemporary local market price of the fodder articles at our disposal.

Current home-raised fodder articles, as fodder corn, corn stover, corn ensilage and sugar beets, served as coarse feed, while corn and cob meal, wheat bran, old-process linseed meal and gluten meal furnished the grain feed for daily diet of the animals on trial. The stated amount of grain feed was in each case a fixed quantity, while the consumption of coarse feed was governed by the appetite of the animal.

One and two year old grade Shorthorn steers, two of each kind, were chosen for the observation. The steers selected were, as far as possible, of a similar general character with reference to breed. They were chosen of a different age to offer a desirable chance to determine *the difference in the cost of the feed* for the production of a corresponding increase in the live weight of both one and two year old animals.

The same kinds of fodder articles served at the same stage of the experiment for all animals engaged in the experiment alike in the compounding of their daily diet; they were, however, given in different proportion and in different quantities to animals of different ages. The daily diet of one and two year old steers was compounded with a due consideration of the wants at the particular age of each lot. Their respective daily diet consequently differed essentially only in regard to quantity and proportion of the same fodder articles.

The local market price of the various fodder articles used at the time of the observation has been adopted as the basis of determining the cost of the daily fodder rations. A loss of eight per cent. of the essential fertilizing constituents contained in the food consumed has been assumed a fair compensation for the amount of nitrogen, phosphoric acid and potassium oxide retained in the growing animal, and thereby lost to the manurial resources of the farm. Accepting E. Wolff's statement of the chemical composition of a live steer as the basis in our calculation of the loss of the above-stated manurial substances, one hundred pounds of increase in the live weight of the steers, at the present market value of phosphoric acid, potassium oxide and nitrogen, represents a loss of from 52 to 55 cents to the manurial resources of the farm. From the previous statement, it will be noticed that ninety-two per cent. of the essential fertilizing constituents contained in the feed consumed are considered available in the manure produced in connection with raising steers for the meat market. The *net cost* of the feed stated in the subsequent report of our financial results represents, therefore, the cost of the feed consumed, after deducting from its original market price ninety-two per cent. of the money value of the essential fertilizing constituents, *i. e.*, nitrogen, phosphoric acid and potassium oxide, it contains.

The statements of the relative proportion of the digestible nitrogenous and non-nitrogenous food constituents of the daily diet (its nutritive ratio) are based on the mean of more recent observations in connection with actual feeding experiments elsewhere (Wolff).

The different daily fodder rations recorded below were compounded with a view to compare different combinations of well-known feed stuffs with reference to feeding effect and to influence on cost of feed. Those daily fodder rations which have given us the most satisfactory results in this connection may be seen below (rations I. and II.).

The general history of the management of the experiment and the financial results of the whole operation are published upon a few subsequent pages. It is for obvious reasons not advisable to enter at this early stage of our experiments upon a detailed critical discussion of the lessons which may be learned from the results obtained. Some facts, however, brought out in the course of the experiment, are apparently so well supported under existing circumstances that a brief statement concerning them may claim some special attention.

Results.

1. Corn ensilage, when fed either with wheat bran and gluten meal, or with wheat bran and old-process linseed meal, has produced in our case, without an exception, the highest gain in live weight, as compared with other fodder rations used in the experiment (see fodder rations I., II., below).

2. The increase in live weight per day, when feeding the ensilage fodder rations (I., II.) to one-year old steers, has in one instance (steer 2) exceeded three pounds, while in the case of two-year old steers it has averaged more than four pounds per day in one case (steer 4).

3. The original cost of the feed (corn ensilage, fodder rations I., II.) consumed per day has been from 12.82 cents to 14.72 cents in case of one-year old steers (1, 2),

and from 16.67 cents to 19.33 cents in case of two-year old steers (3, 4).

4. The net cost of the feed (corn ensilage, fodder rations I., II.) consumed per day has been from 4.81 cents to 5.26 cents in the case of one-year old steers (1, 2), and from 6.65 cents to 7.44 cents in case of two-year old steers.

5. The daily increase in the live weight of the one-year old steers during both periods of feeding ensilage fodder rations (I., II.) averages 2.9 pounds. The original market cost of that diet averages, per day, 13.29 cents, hence the original cost of the feed consumed per pound of live weight gained amounts to 4.8 cents, while the net cost of the feed consumed per pound of live weight gained amounts to 1.82 cents.

6. The daily increase in the live weight of the two-year old steers during both periods of feeding ensilage fodder rations (I., II.) averages 3.45 pounds. The original market cost of that daily diet averages for both periods, per day, 18 cents, hence the original market cost of the feed consumed for every pound of live weight produced amounts to 5.22 cents, while the net cost of the feed consumed per pound of live weight gained amounts to 2.08 cents.

7. The difference in the financial result presented above and of the subsequent financial summaries of the entire feeding experiment is due to the less profitable daily fodder ration used during the experiment in connection with the ensilage fodder rations (I., II.).

Local Market Value per Ton of the Various Articles of Fodder used, 1889-90.

Wheat bran,	$16 50
Gluten meal,	23 00
Old-process linseed meal,	27 50
Corn and cob meal,	16 50
Corn stover,	5 00
Corn ensilage,	2 75
Corn fodder,	7 50
Sugar beets,	5 00

Valuation of Essential Fertilizing Constituents in the Various Articles of Fodder used.

	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Fodder.	Sugar Beets.
Moisture, ...	9.27	9.80	9.88	8.10	26.95	72.95	20.42	90.02
Nitrogen, ...	2.545	4.510	5.331	1.439	.923	.330	1.058	.184
Phosphoric acid, . .	2.900	.392	1.646	.603	.303	1.138	.510	.086
Potassium oxide, .	1.637	.049	1.162	.441	1.320	.301	.760	.462
Valuation per 2,000 lbs.,	$13 60	$16 18	$21 15	$6 02	$4 69	$1 56	$4 89	$1 14

Daily Fodder Rations used.

I.

Wheat bran, ...	3.88	lbs.
Gluten meal, ...	3.88	"
Corn ensilage, ...	37.50	"
Nutritive ratio, ...	1 : 5.49	
Total cost, ...	12.82	cts.
Manurial value obtainable, ...	8.01	"
Net cost, ...	4.81	"

II.

Wheat bran, ...	4.00	lbs.
Old-process linseed meal, ...	4.00	"
Corn ensilage, ...	43.38	"
Nutritive ratio, ...	1 : 5.69	
Total cost, ...	14.76	cts.
Manurial value obtainable, ...	9.50	"
Net cost, ...	5.26	"

III.

Wheat bran, ...	3.00	lbs.
Old-process linseed meal, ...	3.00	"
Corn and cob meal, ...	3.00	"
Corn fodder, ...	9.00	"
Nutritive ratio, ...	1 : 4.93	
Total cost, ...	12.45	cts.
Manurial value obtainable, ...	7.65	"
Net cost, ...	4.80	"

Daily Fodder Rations used — Concluded.

IV.

Wheat bran,	3.00	lbs.
Old-process linseed meal,	3.00	"
Corn and cob meal,	3.00	"
Corn stover,	6.00	"
Nutritive ratio,	1 : 4.55	
Total cost,	10.58	cts.
Manurial value obtainable,	6.92	"
Net cost,	3.66	"

V.

Wheat bran,	3.00	lbs.
Old-process linseed meal,	3.00	"
Corn and cob meal,	3.00	"
Corn stover,	3.60	"
Sugar beets,	20.00	"
Nutritive ratio,	1 : 4.49	
Total cost,	14.98	cts.
Manurial value obtainable,	7.44	"
Net cost,	7.54	"

VI.

Wheat bran,	2.25	lbs.
Gluten meal,	2.25	"
Corn stover,	12.00	"
Nutritive ratio,	1 : 5.51	
Total cost,	7.45	cts.
Manurial value obtainable,	5.68	"
Net cost,	1.77	"

Steer 1 (Yearling).

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Total Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Fodder.	Sugar Beets.					
1889-90.													
Dec. 17 to Dec. 31, . . .	2.27	2.33	–	–	5.27	–	–	–	7.82	1:4.63	675	654	–1.40
Jan. 4 to Jan. 22, . . .	3.88	3.88	–	–	–	37.89	–	–	16.72	1:5.51	667	708	2.16
Jan. 28 to Feb. 16, . . .	4.00	–	4.00	–	–	42.20	–	–	19.30	1:5.63	725	783	2.90
Feb. 21 to March 11, . . .	3.00	–	3.00	3.00	–	–	9.42	–	15.68	1:4.98	785	820	1.84
March 14 to April 21, . . .	3.00	–	3.00	3.00	5.91	–	–	–	12.50	1:4.54	828	880	1.33
April 24 to May 9, . . .	3.00	–	3.00	3.00	3.50	–	–	20.00	12.74	1:4.47	882	895	0.81

Total Amount of Feed consumed from Dec. 17, 1889, to May 9, 1890.

	Dry Matter (Pounds).	Cost.	Manurial Value.
465.50 pounds wheat bran,	422.35	$3 84	$3 17
95.50 pounds gluten meal,	86.14	1 10	0 77
371.00 pounds old-process linseed meal,	334.35	5 10	3 92
239.00 pounds corn and cob meal,	219.64	1 97	0 72
243.50 pounds corn stover,	177.88	0 61	0 57
1,927.00 pounds corn ensilage,	521.25	2 65	1 50
205.50 pounds corn fodder,	163.54	0 77	0 50
350.00 pounds sugar beets,	34.93	0 88	0 20
	1,960.08	$16 92	$11 35

	Pounds.
Live weight of animal at beginning of experiment,	675.00
Live weight of animal at end of feeding,	895.00
Live weight gained during experiment,	220.00
Average gain in weight per day,	1.53
Dry matter consumed per pound of live weight gained,	8.91
Cost of feed per pound of live weight gained,	7.69 cents.
Net cost of feed per pound of live weight gained, allowing 8 per cent. loss of manurial value,	2.95 cents.

Steer 2 (Yearling).

FEEDING PERIODS	Feed consumed (Pounds) per Day.								Total Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Fodder.	Sugar Beets.					
1889-90.													
Dec. 17 to Dec. 31, . . .	2.00	2.07	–	–	5.27	–	–	–	6.53	1:4.76	600	590	-0.67
Jan. 4 to Jan. 22, . . .	3.88	3.88	–	–	–	37.32	–	–	16.54	1:5.47	610	674	3.37
Jan. 28 to Feb. 16, . . .	4.00	–	4.00	–	–	44.55	–	–	19.97	1:5.75	680	745	3.25
Feb. 21 to March 11, . . .	3.00	–	3.00	3.00	–	–	8.53	–	14.97	1:4.87	746	770	1.26
March 14 to April 21, . . .	3.00	–	3.00	3.00	6.00	–	–	–	12.56	1:4.55	776	826	1.28
April 24 to May 9, . . .	3.00	–	3.00	3.00	3.69	–	–	20.00	12.88	1:4.50	828	840	0.75

Total Amount of Feed consumed from Dec. 17, 1889, to May 9, 1890.

	Dry Matter (Pounds).	Cost.	Manurial Value.
465.50 pounds wheat bran,	422.35	$3 84	$3 17
95.50 pounds gluten meal,	86.14	1 10	0 77
371.00 pounds old-process linseed meal,	334.35	5 10	3 92
239.00 pounds corn and cob meal,	219.64	1 97	0 72
354.00 pounds corn stover,	258.60	0 89	0 83
1,942.00 pounds corn ensilage,	525.31	2 67	1 51
285.00 pounds corn fodder,	226.80	1 07	0 70
350.00 pounds sugar beets,	34.93	0 88	0 20
	2,108.12	$17 52	$11 82

	Pounds.
Live weight of animal at beginning of experiment,	600.00
Live weight of animal at end of feeding,	840.00
Live weight gained during experiment,	240.00
Average gain in weight per day,	1.67
Dry matter consumed per pound of live weight gained,	8.78
Cost of feed per pound of live weight gained,	7.30 cents.
Net cost of feed per pound of live weight gained, allowing 8 per cent. loss of manurial value,	2.77 cents.

Summary of Feeding Experiment with Steers One Year Old.

	No. 1.	No. 2.
Beginning of feeding experiment,	Dec. 17, 1889.	Dec. 17, 1889.
Close of feeding experiment,	May 9, 1890.	May 9, 1890.
Number of days of observation,	144	144
Live weight of animals at the beginning of observation,	675 lbs.	600 lbs.
Live weight of animals at the close of observation,	895 "	840 "
Total number of pounds of live weight gained during the experiment,	220 "	240 "
Average gain in live weight per day,	1.53 "	1.67 "
Amount of dry vegetable matter consumed per pound of live weight gained,	8.91 "	8.78 "
Total cost of feed consumed per day,	11.75 cts.	12.16 cts.
Manurial value of feed consumed per day,	7.87 "	8.20 "
Manurial value of feed consumed, allowing 8 per cent. loss,	7.24 "	7.54 "
Net cost of feed consumed per day, allowing a loss of 8 per cent. of manurial value for live weight gained,	4.51 "	4.62 "
Net cost of feed per pound of live weight gained,	2.95 "	2.77 "

Summary of Record of Steers No. 1 and No. 2, when left in the Pasture, May 10, 1889, to Sept. 30, 1889.

	No. 1.	No. 2.
Date of turning steers into pasture,	May 10, 1889.	May 10, 1889.
Date of closing pasturing,	Sept. 30, 1889.	Sept. 30, 1889.
Number of days of pasturing,	144	144
Live weight of steers when turned into pasture,	895 lbs.	840 lbs.
Live weight of steers at the close of pasturing,	1,020 "	923 "
Total weight gained during pasturing,	125 "	83 "
Average gain in weight per day,	0.87 "	0.58 "
Cost of feed per day, allowing 40 cents per week for use of pasture,	5.71 cts.	5.71 cts.
Cost of feed per pound of live weight gained,	6.58 "	9.91 "

Two-year Old Grade Shorthorn Steers.

[The same fodder articles as in the case of the one-year old steers served here.]

Daily Fodder Rations Used.

I.

Wheat bran,	3.88	lbs.
Gluten meal,	3.88	"
Corn ensilage,	65.50	"
Nutritive ratio,	1:6.54	
Total cost,	16.67	cts.
Manurial value obtainable,	10.02	"
Net cost,	6.65	"

II.

Wheat bran,	4.00	lbs.
Old-process linseed meal,	4.00	"
Corn ensilage,	76.60	"
Nutritive ratio,	1:6.75	
Total cost,	19.33	cts.
Manurial value obtainable,	11.89	"
Net cost,	7.44	"

III.

Wheat bran,	4.00	lbs.
Old-process linseed meal,	4.00	"
Corn and cob meal,	4.00	"
Corn fodder,	12.35	"
Nutritive ratio,	1:4.91	
Total cost,	16.73	cts.
Manurial value obtainable,	10.28	"
Net cost,	6.45	"

IV.

Wheat bran,	4.00	lbs
Old-process linseed meal,	4.00	"
Corn and cob meal,	4.00	"
Corn stover,	13.00	"
Nutritive ratio,	1:4.99	
Total cost,	15.35	cts.
Manurial value obtainable,	10.30	"
Net cost,	5.05	"

V.

Wheat bran,	2.65	lbs
Gluten meal,	2.65	"
Corn stover,	18.00	"
Nutritive ratio,	1:5.84	
Total cost,	9.74	cts.
Manurial value obtainable,	7.51	"
Net cost,	2.23	"

Steer No. 3.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Total Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Fodder.					
1889-90.												
Dec. 10 to Dec. 31, ...	2.64	2.68	–	–	9.00	–	–	11.39	1:5.15	1,235	1,192	–1.95
Jan. 4 to Jan. 22, ...	3.88	3.88	–	–	–	68.95	–	24.60	1:6.64	1,210	1,297	4.58
Jan. 28 to Feb. 16, ...	4.00	4.00	–	–	–	80.10	–	30.13	1:6.89	1,310	1,362	2.60
Feb. 21 to March 11, ...	4.00	–	4.00	4.00	–	–	14.00	22.05	1:5.11	1,362	1,366	0.21
March 13 to March 25, ...	4.00	–	4.00	4.00	14.67	–	–	21.63	1:5.09	1,367	1,370	0.23

Total Amount of Feed consumed from Dec. 10, 1889, to March 25, 1890.

	Dry Matter (Pounds).	Cost.	Manurial Value.
387.50 pounds wheat bran, . . .	351.58	$3 20	$2 64
140.50 pounds gluten meal, . . .	126.73	1 62	1 14
248.00 pounds old-process linseed meal,	223.50	3 41	2 62
135.00 pounds corn and cob meal, .	124.07	1 11	0 41
392.00 pounds corn stover, . . .	286.36	0 98	0 92
3,542.00 pounds corn ensilage, . .	958.11	4 87	2 76
315.00 pounds corn fodder, . . .	250.68	1 18	0 77
	2,321.03	$16 37	$11 26

	Pounds.
Live weight of animal at beginning of experiment, . .	1,235.00
Live weight at time of killing, ...	1,370.00
Live weight gained during experiment, ...	135.00
Average gain in weight per day, ...	1.27
Dressed weight of animal, ...	886.00
Loss in weight by dressing, . .	484 pounds, or 35.33 per cent.
Original cost of animal, 1,336 pounds, at 3½ cents, . . .	$46 76
Selling price of animal, 886 pounds, at 6 cents, . . .	53 16
Net cost of feed after deducting 8 per cent. of manurial value,	6 01
Dry matter required to produce 1 pound of live weight, .	17.19 pounds.
Cost of feed per pound gained, ...	12.13 cents.
Net cost of feed per pound gained after deducting 8 per cent of manurial value, ...	4.45 cents

Steer No. 4.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Total Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Fodder.					
1889-90.												
Dec. 10 to Dec. 31,	2.64	2.68	–	–	5.25	–	–	8.65	1:4.45	1,180	1,138	–1.91
Jan. 4 to Jan. 22,	3.88	3.88	–	–	–	62.21	–	20.92	1:6.43	1,162	1,250	4.63
Jan. 28 to Feb. 16,	4.00	4.00	–	–	–	73.10	–	28.13	1:6.70	1,246	1,317	3.55
Feb. 21 to March 11,	4.00	–	4.00	4.00	–	–	10.71	19.43	1:4.81	1,305	1,293	–0.63
March 13 to March 25,	4.00	–	4.00	4.00	11.25	–	–	19.63	1:4.89	1,297	1,300	0.23

Total Amount of Feed consumed from Dec. 10, 1889, to March 25, 1890.

	Dry Matter (Pounds).	Cost.	Manurial Value.
387.50 pounds wheat bran, . . .	351.58	$3 20	$2 64
140.50 pounds gluten meal, . . .	126.73	1 62	1 14
248.00 pounds old-process linseed meal,	223.50	3 41	2 62
135.00 pounds corn and cob meal, .	124.07	1 11	0 41
267.00 pounds corn stover, . . .	195.04	0 67	0 63
3,210.50 pounds corn ensilage, . .	868.44	4 41	2 50
238.00 pounds corn fodder, . . .	189.40	0 89	0 46
	2,078.76	$15 31	$10 40

	Pounds.
Live weight of animal at beginning of experiment, . .	1,180.00
Live weight at time of killing, ...	1,300.00
Live weight gained during experiment, ...	120.00
Average gain in weight per day, ...	1.13
Dressed weight of animal, ...	859.00
Loss in weight by dressing, . .	441 pounds, or 33.92 per cent.
Original cost of animal, 1,332 pounds, at 3½ cents, . . .	$46 62
Selling price of steer, 859 pounds, at 6 cents, ...	51 54
Net cost of feed after deducting 8 per cent. of manurial value,	5 74
Dry matter required to produce 1 pound of live weight, .	17.32 pounds.
Cost of feed per pound gained, ...	12.76 cents.
Net cost of feed per pound gained, after deducting 8 per cent. of manurial value, ...	4.78 cents.

Summary of Feeding Experiments, Steers Two Years Old, Nos. 3 and 4.

	No. 3.	No. 4.
Beginning of feeding experiment,	Dec. 10, 1889.	Dec. 10, 1889.
Close of observation,	Mar. 25, 1890.	Mar. 25, 1890.
Number of days of observation,	106	106
Live weight of animals at the beginning of observation,	1,235 lbs.	1,180 lbs.
Live weight of animals at close of observation,	1,370 "	1,300 "
Total number of pounds of live weight gained during experiment,	135 "	120 "
Average gain in live weight per day,	1.27 "	1.13 "
Amount of dry vegetable matter consumed per pound of live weight gained,	17.19 "	17.32 "
Total cost of feed consumed per day,	15.44 cts.	14.44 cts.
Manurial value of feed consumed per day,	10.62 "	9.82 "
Manurial value of feed consumed per day, allowing 8 per cent. loss,	9.77 "	9.03 "
Net cost of feed consumed per day, allowing a loss of 8 per cent. of manurial value,	5.67 "	5.41 "
Net cost of feed consumed per pound of live weight gained,	4.45 "	4.78 "
Selling price of dressed weight,	6.00 "	6.00 "
Per cent. of shrinkage in dressing beef for the market,	35.3	33.9

Analyses of Fodder Articles used in the Experiment.

Corn and Cob Meal.

1889-90.

	Per Cent.
Moisture at 100° C.,	8.10
Dry matter,	91.90
	100.00

Analysis of Dry Matter.

Crude ash,	1.47
" cellulose,	5.63
" fat,	3.73
" protein (nitrogenous matter),	9.79
Non-nitrogenous extract matter,	79.38
	100.00
Passed screen, 144 meshes to square inch,	76.34

Wheat Bran (Average).

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.27	185.40	–	–	1:3.94
Dry matter,	90.73	1,814.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.47	149.40	–	–	
" cellulose,	9.75	195.00	39.00	20	
" fat,	5.48	109.60	87.68	80	
" protein (nitrogenous matter),	17.53	350.60	308.53	88	
Non-nitrogenous extract matter,	59.77	1,195.40	956.32	80	
	100.00	2,000.00	1,391.53	–	

Gluten Meal.

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.80	196.00	–	–	1:2.60
Dry matter,	90.20	1,804.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.25	25.00	–	–	
" cellulose,	1.75	35.00	11.90	34	
" fat,	7.00	140.00	106.40	76	
" protein (nitrogenous matter),	31.25	625.00	531.25	85	
Non-nitrogenous extract matter,	58.75	1,175.00	1,104.50	94	
	100.00	2,000.00	1,754.05	–	

Old-process Linseed Meal (Average).

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	9.88	197.60	–	–	1 : 1.70
Dry matter, ...	90.12	1,802.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	7.39	147.80	–	–	
" cellulose, . . .	8.74	174.80	45.45	26	
" fat, ...	7.24	144.80	131.77	91	
" protein (nitrogenous matter), . .	36.97	739.40	643.28	87	
Non-nitrogenous extract matter, ...	39.66	793.20	721.81	91	
	100.00	2,000.00	1,542.31	–	

Sugar Beets.

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	90.02	1,800.40	–	–	1 : 6.74
Dry matter, ...	9.98	199.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	11.84	236.80	–	–	
" cellulose, . . .	8.20	164.00	164.00	100	
" fat, ...	.71	14.20	14.20	100	
" protein (nitrogenous matter), . .	11.53	230.60	230.60	100	
Non-nitrogenous extract matter, ...	67.72	1,354.40	1,354.40	100	
	100.00	2,000.00	1,763.20	–	

Corn Ensilage (Average).

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	72.95	1,459.00	–	–	1 : 11.67
Dry matter,	27.05	541.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.48	129.60	–	–	
" cellulose,	26.33	526.60	379.15	72	
" fat,	5.17	103.40	77.55	75	
" protein (nitrogenous matter),	7.64	152.80	111.54	73	
Non-nitrogenous extract matter,	54.38	1,087.60	728.69	67	
	100.00	2,000.00	1,296.93	–	

Corn Fodder.

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	20.42	408.40	–	–	1 : 9.80
Dry matter,	79.58	1,591.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.40	148.00	–	–	
" cellulose,	20.11	402.20	289.58	72	
" fat,	1.65	33.00	24.75	75	
" protein (nitrogenous matter),	8.31	166.20	121.33	73	
Non-nitrogenous extract matter,	62.53	1,250.60	837.90	67	
	100.00	2,000.00	1,273.56	–	

Corn Stover.

[From Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	19.89
Dry matter,	80.11
	100.00

Analysis of Dry Matter.

Crude ash,	6.33
" cellulose,	34.59
" fat,	1.28
" protein (nitrogenous matter),	5.74
Non-nitrogenous extract matter,	52.06
	100.00

III.

FEEDING EXPERIMENTS WITH LAMBS.

SEPTEMBER 30, 1890, TO APRIL 20, 1891.

The feeding experiment with lambs described below is the second of a series devised to ascertain the influence of different fodder rations on the cost of feed when fattening lambs during the winter for the meat market.

The selection of animals was made from the temporary supply of our local market. Six lambs, wethers, grades of uncertain parentage, served for the trial; they were shorn before being weighed at the beginning of the observation. Each animal occupied a separate pen during the entire experiment. They received during the first week the same daily diet, and were subsequently divided into two lots of three each (lots A and B), to test the effect of different grain feed rations on the ultimate financial results of the operation.

1. *Weight of Lambs.*

		Original Live Weight of Lambs (Pounds).	Weight of Wool removed (Pounds).	Live Weight at the Beginning (Pounds).
LOT A.	1, ...	50.25	2.75	47.50
	2, ...	64.00	3.50	60.50
	3, ...	62.50	4.50	58.00
		176.75	10.75	166.00
LOT B.	4, ...	52.25	2.75	49.50
	5, ...	63.75	1.75	62.00
	6, ...	52.00	1.50	50.50
		168.00	6.00	162.00

2. *Cost of Lambs.*

The entire lot was bought at 5 cents per pound of live weight, and the sum paid for the entire original live weight of 344.75 pounds amounted to $17.24.

The wool subsequently secured before the beginning of the feeding experiment was sold at 25 cents per pound, or $4.19 for 16.75 pounds of wool.

Deducting the sum of $4.19 obtained for the wool removed from the first cost of the lambs, which was $17.24, it will be noticed that their actual cost was but $13.05, or 3.98 cents per pound of live weight. Their live weight after the removal of the wool amounted to 328 pounds.

Lot A.	1.	47.50 pounds, at 3.98 cents,	$1 89	$6 61
	2.	60.50 pounds, at 3.98 cents,	2 41	
	3.	58.00 pounds, at 3.98 cents,	2 31	
Lot B.	4.	49.50 pounds, at 3.98 cents,	$1 97	$6 44
	5.	62.00 pounds, at 3.98 cents,	2 46	
	6.	50.50 pounds, at 3.98 cents,	2 01	

3. *Character and Cost of Fodder Articles used.*

The grain feed rations of the daily diet contained, at different times and in varying proportions, corn meal, wheat bran, old-process linseed meal and Chicago gluten meal; while rowen — hay of second cut of upland meadows — and corn ensilage furnished its coarse feed constituent. The corn ensilage was produced from a dent corn variety, Pride of the North, which was cut when the kernels began to glaze.

The grain feed stuffs were bought in our local market; they were fair articles of their kind. Their relative composition and general economical value will be seen from the subsequent statements.

ANALYSES OF FODDER ARTICLES USED.	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.
Moisture at 100° C.,	13.26	12.11	8.72	10.90	13.90	80.53
Dry matter,	86.74	87.89	91.29	89.10	86.10	19.47
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude ash,	1.72	7.40	5.96	1.02	8.28	6.73
" cellulose,	2.28	12.17	8.23	1.28	28.88	26.90
" fat,	4.90	5.04	9.87	7.36	3.91	3.27
" protein (nitrogenous matter),	12.94	18.48	36.19	34.79	13.45	8.97
Non-nitrogenous extract matter,	78.16	56.91	39.75	55.55	45.48	54.13
	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing constituents of the above fodder articles: Nitrogen, 15 cents; phosphoric acid, 5½ cents; potassium oxide, 4½ cents per pound.

Moisture,	13.26	12.11	8.72	10.90	13 90	80.53
Nitrogen,	1.796	2.599	5.285	4.959	1.853	.279
Phosphoric acid,	.707	2.845	1.780	.425	.464	.101
Potassium oxide,	.435	1.625	1.214	.045	1.966	.226
Valuation per 2,000 pounds,	$6 56	$12 39	$18 90	$15 38	$7 84	$1 15

Local Market Value per Ton of the Various Articles of Fodder used (1890–1891).

Corn meal,	$28 00
Wheat bran,	25 00
Old-process linseed meal,	26 00
Gluten meal,	28 00
Rowen,	15 00
Corn ensilage,	2 75

4. Mode of Feeding.

The time occupied by the experiment amounted to two hundred and two days; it was divided into four feeding periods. The first feeding period extended over fourteen days, the second lasted ninety-eight days, the third thirty-four days and the fourth forty-one days. Eight days were usually allowed to pass by between succeeding feeding periods before the results accompanying the changes made in the diet were recorded. Each animal was kept in a separate pen; all received during the first period the same daily diet. This course was adopted to give each a fair chance in feed, and to bring all animals as far as practicable into a desirable uniform condition for a subsequent comparative test regarding the merits and good economy of different grain feed rations for meat production. They received their feed twice a day. At the close of the first feeding period a division of the lambs into two lots, A and B, each numbering three, was made for the purpose of *testing different grain feed rations in connection with the same article of coarse feed.*

The daily grain feed ration during *the first feeding period* consisted of a mixture of two weight parts of wheat bran and one weight part of old-process linseed meal. Eight ounces of this mixture were fed, per head, for every pound of rowen consumed. The amount of the grain feed mixture consumed daily per head varied from twelve to fourteen ounces, and that of rowen from one and one-half pounds to one and three-quarters pounds in case of different animals. *Subsequently two different combinations of grain feed were fed to the two lots of lambs* (A and B).

The daily grain feed ration in case of Lot A (1, 2 and 3) consisted of a mixture of ten weight parts of corn meal, two weight parts of wheat bran and one weight part of Chicago gluten meal. Lot B (4, 5 and 6) received as daily grain feed ration, during the same time, a mixture of two weight parts of wheat bran and one weight part of Chicago gluten meal.

Rowen and rowen with corn ensilage furnished alternately for both lots at corresponding periods the coarse feed portion of their daily diet. *Both lots of lambs received as their daily diet eight ounces of their respective grain feed mixture* in connection with *one pound of rowen* or *one-third of one pound of rowen, with all the corn ensilage they would consume* ($2\frac{3}{4}$ to 3 pounds). The daily diet of both lots differed essentially in regard to the relative proportion of digestible nitrogenous and non-nitrogenous food constituents they contained.

The fodder rations fed to lambs 1, 2, 3 were *less rich* in nitrogenous constituents (1 : 6.50 to 1 : 7.40) than those fed to lambs 4, 5, 6 (1 : 4.50 to 1 : 5.00). The subsequent statement contains the average composition of the daily fodder ration (per head) during the succeeding periods. Twenty per cent. of the phosphoric acid, potassium oxide and nitrogen contained in the feed consumed has been allowed as stored up in the increased live weight of the animal, and otherwise lost to the manurial refuse.

Average Daily Fodder Rations used for Lambs Nos. 1, 2 and 3.

I.

Wheat bran,	0.50	lbs.
Old-process linseed meal,	0.25	"
Rowen,	1.40	"
Nutritive ratio,	1 : 4.32	
Total cost,	2.00	cts.
Net cost,	0.99	"
Manurial value obtainable,	1.01	"

II.

Corn meal,	0.60	lbs.
Wheat bran,	0.12	"
Gluten meal,	0.06	"
Rowen,	1.35	"
Nutritive ratio,	1 : 6.51	
Total cost,	2.08	cts.
Net cost,	1.30	"
Manurial value obtainable,	0.78	"

III.

Corn meal,	0.60	lbs.
Wheat bran,	0.12	"
Gluten meal,	0.06	"
Rowen,	0.38	"
Corn ensilage,	3.56	"
Nutritive ratio,	1 : 7.40	
Total cost,	1.85	cts.
Net cost,	1.23	"
Manurial value obtainable,	0.62	"

Average Daily Fodder Rations, etc. — Concluded.

IV.

Corn meal,	0.73 lbs.
Wheat bran,	0.15 "
Gluten meal,	0.07 "
Rowen,	1.64 "
Nutritive ratio,	1 : 6.50
Total cost,	2.53 cts.
Net cost,	2.14 "
Manurial value obtainable,	0.39 "

Average Daily Fodder Rations used for Lambs Nos. 4, 5 and 6.

I.

Wheat bran,	0.53 lbs.
Old-process linseed meal,	0.27 "
Rowen,	1.42 "
Nutritive ratio,	1 : 4.27
Total cost,	2.08 cts.
Net cost,	1.02 "
Manurial value obtainable,	1.06 "

II.

Wheat bran,	0.56 lbs.
Gluten meal,	0.28 "
Rowen,	1.48 "
Nutritive ratio,	1 : 4.55
Total cost,	2.20 cts
Net cost,	1.14 "
Manurial value obtainable,	1.06 "

III.

Wheat bran,	0.48 lbs.
Gluten meal,	0.24 "
Rowen,	0.38 "
Corn ensilage,	3.33 "
Nutritive ratio,	1 : 5.01
Total cost,	1.69 cts.
Net cost,	0.94 "
Manurial value obtainable,	0.75 "

IV.

Wheat bran,	0.60 lbs.
Gluten meal,	0.30 "
Rowen,	1.34 "
Nutritive ratio,	1 : 4.51
Total cost,	2.17 cts.
Net cost,	1.13 "
Manurial value obtainable,	1.04 "

Summary of Cost of Above-stated Fodder Rations.

A. — Lambs 1, 2 and 3.

FEEDING PERIODS.	I. Cents.	II. Cents.	III. Cents.	IV. Cents.
Total cost of feed consumed,	2.00	2.08	1.85	2.53
Manurial value obtainable (80 per cent.),	1.01	0.78	0.62	0.39
Net cost of feed,	0.99	1.30	1.23	2.14

B. — Lambs 4, 5 and 6.

FEEDING PERIODS.	I. Cents.	II. Cents.	III. Cents.	IV. Cents.
Total cost of feed consumed,	2.08	2.20	1.69	2.17
Manurial value obtainable (80 per cent.),	1.06	1.06	0.75	1.04
Net cost of feed,	1.02	1.14	0.94	1.13

5. *Gain in Live Weight during Experiment.*

Lot A.

	Live Weight at the Beginning of Experiment (Pounds).	Live Weight at Close of Experiment (Pounds).	Gain in Live Weight during Experiment (Pounds).
1,	47.50	93.50	46.00
2,	60.50	98.75	38.25
3,	58.00	109.75	51.75
Average,	55.33	100.67	45.33

Lot B.

	Live Weight at the Beginning of Experiment (Pounds).	Live Weight at Close of Experiment (Pounds).	Gain in Live Weight during Experiment (Pounds).
4,	49.50	81.25	31.75
5,	62.00	101.25	39.25
6,	50.00	103.00	53.00
Average,	53.83	95.17	41.33

Lot A gained in live weight per head, on an average, 0.224 pounds.

Lot B gained in live weight per head, on an average, 0.205 pounds.

Amount of Raw Wool secured after the Close of the Experiment.

Lot A.

	Live Weight with Wool (Pounds).	Live Weight after Shearing (Pounds).	Amount of Wool obtained (Pounds).
1,	93.50	89.00	4.50
2,	98.75	93.25	5.50
3,	109.75	104.00	5.75
	302.00	286.25	15.75
Lot B.			
4,	81.25	76.00	5.25
5,	101.25	97.00	4.25
6,	103.00	97.75	5.25
	285.50	270.75	14.75

6. *Financial Statement.*

The wool was sold at 25 cents per pound and the pelt at 12.5 cents. The difference between the live weights of the animals 1, 2 and 3 at the close of the experiment, and their dressed weights, varied from 49 per cent. to 52 per cent., and averaged per head 51.2 per cent.; in case of animals 4, 5 and 6 it varied from 45 per cent. to 52 per cent., and averaged per head 48.6 per cent.

Yield of Dressed Weight.

1. 47.00 pounds, at 11 cents,	$5 17
2. 48.00 pounds, at 11 cents,	5 28
3. 52.25 pounds, at 11 cents,	5 75
147.25 pounds,	$16 20
4. 42.00 pounds, at 11 cents,	$4 62
5. 55.50 pounds, at 11 cents,	6 11
6. 49.00 pounds, at 11 cents,	5 39
146.50 pounds,	$16 12

Yield of Dressed Weight — Concluded.

Lot A.

	1.	2.	3.	Total.
Cost of lambs,	$1 89	$2 41	$2 31	$20 58
Cost of feed consumed,	4 30	4 46	5 21	
	$6 19	$6 87	$7 52	
Value received for meat,	$5 17	$5 28	$5 75	$25 07
Value received for wool and pelt,	1 25	1 50	1 56	
Value of obtainable manure,	1 41	1 46	1 69	
	$7 83	$8 24	$9 00	

Lot B.

	4.	5.	6.	Total.
Cost of lambs,	$1 97	$2 46	$2 01	$20 86
Cost of feed consumed,	3 49	5 26	5 67	
	$5 46	$7 72	$7 68	
Value received for meat,	$4 62	$6 11	$5 39	$26 14
Value received for wool and pelt,	1 44	1 19	1 44	
Value of obtainable manure,	1 44	2 17	2 34	
	$7 50	$9 47	$9 17	

Market Cost of Fodder Articles for 1890–91, as compared with 1889–90.

	1889-90.	1890-91.
	Per Ton.	Per Ton.
Corn meal,	$19 00	$28 00
Wheat bran,	17 00	25 00
Old-process linseed meal,	27 00	26 00
Gluten meal,	23 00	28 00
Corn ensilage,	2 75	2 75
Rowen,	15 00	15 00

Total Cost of Feed consumed, counted on Basis of 1889–90 and of 1890–91.

	1889-90.	1890-91.
Sheep 1,	$3 61	$4 30
Sheep 2,	3 74	4 46
Sheep 3,	4 38	5 21
Sheep 4,	3 00	3 49
Sheep 5,	4 54	5 26
Sheep 6,	4 93	5 67
	$24 20	$28 39

Conclusions.

1. The increase in live weight during the first feeding period is, in four out of six cases, lower than in any other period, and affects seriously the financial results of the whole experiment.

2. The total increase per head in live weight per day averages for the entire time of the experiment .23 pounds for Lot A (1, 2 and 3), and .22 pounds for Lot B (4, 5 and 6). In one case it amounts to .39 pounds per day (Lot A, 2, Period IV.); in nine cases it rises above .25 pounds.

3. The market cost of the daily individual fodder rations varies in different feeding periods from 1.69 cents to 2.53 cents. The rations that contain from three to four pounds of corn ensilage, in place of three-fourths of the rowen of other rations, furnish the cheapest daily diet (Period III., Lot A, 1.85 cents, and Lot B, 1.69 cents).

4. The market cost of the feed consumed during the experiment by the lambs of Lot A amounts per head to $4.66, and in case of Lot B to $4.81, — a difference of 15 cents. The three lambs of Lot A cost $6.62, those of Lot B cost $6.47; making cost of lambs and of the feed consumed $20.58 in case of the former, and $20.86 in case of the latter.

5. Dressed lambs, wool and pelts, brought, in case of Lot A, $20.51, and in case of Lot B, $20.19.

6. The obtainable manurial value of the feed consumed by the lambs of Lot A averages per head $1.52, or one-third of the market cost of the feed, and amounts to $1.95 per head, or two-fifths of the market cost of the feed consumed in case of the lambs of Lot B, — a difference of $0.45 per head in favor of the latter, or $4.56 for Lot A and $5.95 for Lot B, — a difference of $1.39 in favor of the latter.

7. The value of the obtainable manure, amounting from ten to eleven dollars for the entire operation, represents the profits of the experiment, aside from disposing of our home-raised fodder articles at a liberal retail market price.

8. The advance on the market cost of the concentrated commercial feed stuffs used in the experiment of 1890–91, as compared with that of 1889–90, amounts to $4.19 as far as the feed consumed is concerned, or 70 cents per head.

Sheep No. 1.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
1890-91.											
Sept. 30 to Oct. 13,	–	0.45	0.23	–	1.25	–	1.68	0.11	15.27	1:4.30	47.50
Oct. 14 to Jan. 19,	0.61	0.12	–	0.06	1.39	–	1.89	0.20	9.45	1:6.50	60.00
Jan. 27 to March 2,	0.58	0.12	–	0.06	0.40	3.53	1.69	0.21	8.05	1:7.39	74.50
March 10 to April 20,	0.73	0.15	–	0.07	1.63	–	2.22	0.33	6.73	1:6.51	86.50

Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
118.27 pounds corn meal,	102.59	$1 66	$0 39
29.98 pounds wheat bran,	26.35	0 37	0 19
3.17 pounds old-process linseed meal,	2.89	0 04	0 03
11.83 pounds gluten meal,	10.54	0 17	0 09
247.25 pounds rowen,	212.88	1 85	0 97
155.00 pounds corn ensilage,	30.18	0 21	0 09
	385.43	$4 30	$1 76

	Pounds.
Live weight of animal at beginning of experiment,	47.50
Live weight at time of killing,	93.50
Live weight gained during experiment,	46.00
Average gain in weight per day,	0.23
Dressed weight of animal,	47.00
Loss in weight by dressing,	46.5 pounds, or 49.73 per cent.
Pounds of dry matter fed produced 1 pound of live weight,	8.38
Cost of feed per pound of live weight gained,	9.35 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value,	5.83 cents.

Sheep No. 2.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
1890-91.											
Sept. 30 to Oct. 13,	–	0.53	0.27	–	1.46	–	1.97	0.07	28.14	1:4.30	60.50
Oct. 14 to Jan. 19,	0.60	0.12	–	0.06	1.33	–	1.83	0.13	14.08	1:6.51	69.00
Jan. 27 to March 2,	0.63	0.13	–	0.06	0.50	3.80	1.88	0.28	6.71	1:7.38	80.00
March 10 to April 20,	0.75	0.15	–	0.08	1.73	–	2.34	0.39	6.00	1:6.50	92.50

Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
121.73 pounds corn meal, ...	105.59	$1 70	$0 40
31.75 pounds wheat bran, ...	27.91	0 40	0 20
3.70 pounds old-process linseed meal, .	3.38	0 05	0 03
12.17 pounds gluten meal, ...	10.84	0 17	0 09
254.00 pounds rowen, ...	218.69	1 91	1 00
169.50 pounds corn ensilage, ...	33.00	0 23	0 10
	399.41	$4 46	$1 82

	Pounds.
Live weight of animal at beginning of experiment, ...	60.50
Live weight at time of killing, ...	98.75
Live weight gained during experiment, ...	38.25
Average gain in weight per day, ...	0.19
Dressed weight of animal, ...	48.00
Loss in weight by dressing, . .	50.75 pounds, or 51.39 per cent.
Pounds of dry matter fed produced 1 pound of live weight, .	10.44
Cost of feed per pound of live weight gained, ...	11.66 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value, ...	7.29 cents.

Sheep No. 3.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
1890-91.											
Sept. 30 to Oct. 13,	–	0.53	0.27	–	1.50	–	2.00	0.27	7.41	1:4.36	59.75
Oct. 14 to Jan. 19,	0.69	0.14	–	0.07	1.63	–	2.18	0.24	9.08	1:6.50	72.00
Jan. 27 to March 2,	0.75	0.15	–	0.08	0.50	4.91	2.24	0.24	9.31	1:7.43	90.75
March 10 to April 20,	0.90	0.18	–	0.09	2.05	–	2.79	0.27	13.33	1:6.50	104.75

Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.

	Dry Matter (Pounds)	Cost.	Manurial Value.
141.54 pounds corn meal,	122.77	$1 98	$0 46
35.71 pounds wheat bran,	31.39	0 45	0 22
3.70 pounds old-process linseed meal,	3.38	0 05	0 03
14.15 pounds gluten meal,	12.61	0 20	0 11
299.25 pounds rowen,	256.66	2 24	1 17
209.50 pounds corn ensilage,	40.79	0 29	0 12
	467.60	$5 21	$2 11

	Pounds.
Live weight of animal at beginning of experiment,	58.00
Live weight at time of killing,	109.75
Live weight gained during experiment,	51.75
Average gain in weight per day,	0.25
Dressed weight of animal,	52.25
Loss in weight by dressing,	57.50 pounds, or 52.39 per cent.
Pounds of dry matter fed produced 1 pound of live weight,	9.04
Cost of feed per pound of live weight gained,	10.07 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value,	6.32 cents.

Sheep No. 4.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
1890-91.											
Sept. 30 to Oct. 13,	–	0.50	0.25	–	1.21	–	1.71	0.18	9.50	1:4.20	50.25
Oct. 14 to Jan. 19,	–	0.44	–	0.22	0.98	–	1.42	0.13	10.92	1:4.42	59.00
Jan. 27 to March 2,	–	0.42	–	0.21	0.41	3.00	1.48	0.21	7.05	1:5.09	68.25
March 10 to April 20,	–	0.57	–	0.28	1.42	–	1.98	0.26	7.62	1:4.51	78.25

Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
95.33 pounds wheat bran,	83.79	$1 19	$0 59
3.50 pounds old-process linseed meal,	3.19	0 05	0 03
44.17 pounds gluten meal,	39.36	0 62	0 34
193.25 pounds rowen,	166.39	1 45	0 76
130.50 pounds corn ensilage,	25.41	0 18	0 08
	318.14	$3 49	$1 80

	Pounds.
Weight of animal at beginning of experiment,	49.50
Live weight at time of killing,	81.25
Live weight gained during experiment,	31.75
Average gain in weight per day,	0.16
Dressed weight of animal,	42.00
Loss in weight by dressing,	39.25 pounds, or 48.31 per cent.
Pounds of dry matter fed produced 1 pound live weight,	10.02
Cost of feed per pound of live weight gained,	10.99 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value,	5.76 cents.

Sheep No. 5.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
1890-91.											
Sept. 30 to Oct. 13,	–	0.57	0.29	–	1.71	–	2.23	0.21	10.62	1:4.36	62.50
Oct. 14 to Jan. 19,	–	0.67	–	0.33	1.78	–	2.41	0.19	12.68	1:4.56	76.00
Jan. 27 to March 2,	–	0.65	–	0.33	0.43	4.76	2.16	0.29	7.45	1:5.02	90.50
March 10 to April 20,	–	0.72	–	0.36	1.87	–	2.56	8.24	10.66	1:4.53	100.25

Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
136.50 pounds wheat bran, . . .	119.97	$1 71	$0 85
4.00 pounds old-process linseed meal, .	3.65	0 05	0 04
64.25 pounds gluten meal, . . .	57.25	0 91	0 49
308.50 pounds rowen, ...	265.62	2 31	1 21
202.00 pounds corn ensilage, . . .	39.33	0 28	0 12
	485.82	$5 26	$2 71

	Pounds.
Live weight of animal at beginning of experiment, . . .	62.00
Live weight at time of killing, ...	101.25
Live weight gained during experiment, ...	39.25
Average gain in weight per day, ...	0.19
Dressed weight of animal, ...	55.50
Loss in weight by dressing, . . 45.75 pounds, or	45.16 per cent.
Pounds of dry matter fed produced 1 pound of live weight, .	12.38
Cost of feed per pound of live weight gained, ...	13.40 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value, ...	7.06 cents.

Sheep No. 6.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
1890-91.											
Sept. 30 to Oct. 13,	-	0.53	0.27	-	1.34	-	1.87	0.14	13.36	1:4.24	50.50
Oct. 14 to Jan. 19,	-	0.67	-	0.33	1.89	-	2.51	0.27	9.30	1:4.61	65.50
Jan. 27 to March 2,	-	0.67	-	0.33	0.50	5.23	2.33	0.29	8.03	1:5.15	84.00
March 10 to April 20,	-	0.87	-	0.43	2.50	-	3.29	0.27	12.19	1:4.62	96.25

Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
142.74 pounds wheat bran,	125.45	$1 78	$0 88
3.70 pounds old-process linseed meal,	3.38	0 05	0 03
67.67 pounds gluten meal,	60.29	0 95	0 52
345.75 pounds rowen,	297.69	2 59	1 36
220.00 pounds corn ensilage,	42.83	0 30	0 13
	529.64	$5 67	$2 92

	Pounds.
Live weight of animal at beginning of experiment,	50.00
Live weight at time of killing,	103.00
Live weight gained during experiment,	53.00
Average gain in weight per day,	0.26
Dressed weight of animal,	49.00
Loss in weight by dressing,	54.00 pounds, or 52.43 per cent.
Pounds of dry matter fed produced 1 pound of live weight,	9.99
Cost of feed per pound of live weight gained,	10.70 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value,	5.62 cents

Fodder Articles used in the Experiment.

Corn Meal (Average).

1890-1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds	Pounds Digestible in a Ton of 2,000 Pounds	Per Cent. of Digestibility of Constituents	Nutritive Ratio.
Moisture at 100° C.,	13.26	265.20	–	–	1 : 8.62
Dry matter,	86.74	1,734.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.72	34.40	–	–	
" cellulose,	2.28	45.60	21.89	48	
" fat,	4.90	98.00	83.30	85	
" protein (nitrogenous matter),	12.94	258.80	204.45	79	
Non-nitrogenous extract matter,	78.16	1,563.20	1,531.94	98	
	100.00	2,000.00	1,841.58	–	

Wheat Bran (Average).

1890-1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	12.11	242.20	–	–	1 : 3.86
Dry matter,	87.89	1,757.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.40	148.00	–	–	
" cellulose,	12.17	243.40	58.42	24	
" fat,	5.04	100.80	71.57	71	
" protein (nitrogenous matter),	18.48	369.60	288.29	78	
Non-nitrogenous extract matter,	56.91	1,138.20	876.41	77	
	100.00	2,000.00	1,294.69	–	

Old-process Linseed Meal.

1890-1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	8.72	174.40	–	–	1 : 1.93
Dry matter, . . .	91.28	1,825.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, . . .	5.96	119.20	–	–	
" cellulose, . . .	8.23	164.60	42.79	26	
" fat, ...	9.87	197.40	179.63	91	
" protein (nitrogenous matter), . .	36.19	723.80	629.70	87	
Non-nitrogenous extract matter, ...	39.75	795.00	723.45	91	
	100.00	2,000.00	1,575.57	–	

Gluten Meal.

1890-1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	10.90	218.00	–	–	1 : 2.44
Dry matter, . . .	89.10	1,782.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	1.02	20.40	–	–	
" cellulose, . . .	1.28	25.60	15.87	62	
" fat, ...	7.36	147.20	125.12	85	
" protein (nitrogenous matter), . .	34.79	695.80	549.68	79	
Non-nitrogenous extract matter, ...	55.55	1,111.00	1,011.01	91	
	100.00	2,000.00	1,701.68	–	

Rowen (Average).

1890-1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	13.90	278.00	–	–	1 : 6.35
Dry matter, . . .	86.10	1,722.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	8.28	165.60	–	–	
" cellulose, . . .	28.88	577.60	369.66	64	
" fat, ...	3.91	78.20	35.97	46	
" protein (nitrogenous matter), . .	13.45	269.00	166.78	62	
Non-nitrogenous extract matter, ...	45.48	909.60	600.34	66	
	100.00	2,000.00	1,172.75	–	

Corn Ensilage.

1890-1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	80.53	1,610.60	–	–	1 : 9.26
Dry matter, . . .	19.47	389.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	6.73	134.60	–	–	
" cellulose, . . .	26.90	538.00	387.36	72	
" fat, ...	3.27	65.40	49.05	75	
" protein (nitrogenous matter), . .	8.97	179.40	134.55	75	
Non-nitrogenous extract matter, ...	54.13	1,082.60	736.17	68	
	100.00	2,000.00	1,307.13	–	

IV.

THREE FEEDING EXPERIMENTS WITH PIGS (THOROUGHBREDS).

1890-1891.

Breeds: Small Yorkshires, Berkshires, Poland Chinas, Tamworths.

Feed: Creamery buttermilk, home skim-milk, corn meal, wheat bran, gluten meal (Chicago variety).

The general management of these experiments was similar to that adopted in our late pig-feeding experiments with grades. From two to three animals of each breed served in our trial.

Three experiments were carried on in succession. The Small Yorkshires were kindly furnished by Messrs. Warren Heustis & Sons, Belmont, Mass.; Berkshires by Col. Henry L. Russell, Milton, Mass.; Poland Chinas by Mr. Smith Harding, South Deerfield, Mass.; Tamworths by Mr. Joshua M. Sears, Boston, Mass.

Weight of Animals at the Beginning of the Experiments.

I.	Small Yorkshires,	24 to 26 pounds.
	Berkshires,	26 to 36 pounds.
	Poland Chinas,	20 to 22 pounds.
	Tamworths,	21 to 24 pounds.
II.	Small Yorkshires,	42 to 52 pounds.
	Berkshires,	20 to 23 pounds.
	Poland Chinas,	42 to 50 pounds.
	Tamworths,	34 to 38 pounds.
III.	Small Yorkshires,	26 to 27 pounds.
	Berkshires,	23 to 26 pounds.
	Poland Chinas,	23.5 to 24 pounds
	Tamworths,	38 to 42 pounds.

Average Composition of Fodder Rations used during the Three Feeding Periods of Each Feeding Experiment.

Experiment I.

FEEDING PERIODS.	Corn Meal.	Wheat Bran.	Gluten Meal.	Skim-milk.	Buttermilk.
	Ounces.	Ounces.	Ounces.	Quarts.	Quarts.
I., ...	10	3½	7	–	5
II., ...	29½	9½	9½	–	5
III., ...	57	13½	13½	5	–
Experiment II.					
I., ...	6	6	12	3	–
II , ...	22½	8½	8½	3½	–
III., ...	35	5½	5½	4	–
Experiment III.					
I , ...	11	6	12	5½	–
II., ...	31½	11½	11½	5	–
III., ...	52	11	11	5	–

The amount of milk used was controlled by our daily supply and by the number of pigs under observation. During the first experiment creamery buttermilk was fed during the two first feeding periods; during the remaining time home-made skim-milk alone was used. As a general rule during the entire experiment the following system was adopted for compounding the daily diet in different feeding periods : —

Period I. For each one quart skim-milk to two ounces of corn meal.

Period II. For each, one quart skim-milk to four ounces of corn meal.

Period III. For each, one quart skim-milk to six ounces of corn meal.

The daily quantity of this feed was governed by the appetite of each animal. Whenever the supply of either kind of milk, or of both kinds, was exhausted, the additional feed called for was prepared in the following manner : —

		Nutritive Ratio.
Period I.	Wheat bran, one weight part, ...	1 : 2.80
	Gluten meal, two weight parts, ...	
Period II.	Corn meal, one weight part, ...	1 : 3.80
	Wheat bran, one weight part, ...	
	Gluten meal, one weight part, ...	
Period III.	Corn meal, two weight parts, ...	1 : 4.35
	Wheat bran, one weight part, ...	
	Gluten meal, one weight part, ...	

The entire management of the feeding was divided, as will be noticed, into three periods, as far as the nutritive character of the daily diet was concerned.

	Live Weight.	Nutritive Ratio.
Period I., ...	20 to 90 pounds, . .	1 : 2.80
Period II., ...	90 to 130 pounds, . .	1 : 3.80
Period III., ...	130 to 200 pounds,. .	1 : 4.35

During the summer season the feed was given twice a day ; during the winter season, three times. Whenever the milk did not satisfy the thirst of the animals warm water was added to the grain to meet the temporary wants.

The results of the two first experiments, being more of an experimental character, are subsequently given in a brief abstract ; the third experiment is reported also in regard to all details of a special interest. Those animals which for more than a few days refused to consume a fair share of their daily diet are excluded from the record, in common with a few losses soon after their arrival during our first and second experiment.

Summary of Experiment I. (May 13 to Oct. 15, 1890).

	Corn Meal (Pounds).	Buttermilk (Quarts).	Skim-milk (Quarts).	Wheat Bran (Pounds).	Gluten Meal (Pounds).	Live Weight gained during Experiment.	Dressed Weight gained during Experiment.	Cost per Pound of Dressed Pork (Cents).
Small Yorkshires, 2 pigs,	560.35	1,129.00	355.00	153.74	187.18	367.25	311.75	4.79
Poland China,	305.10	558.50	177.50	95.65	116.38	215.50	180.00	4.57
Berkshires, 3 pigs,	721.71	1,491.50	532.50	211.42	250.36	512.25	415.50	4.80
Tamworths, 2 pigs,	478.53	889.00	355.00	137.29	156.50	354.75	283.75	4.52

Local Market Cost of Fodder Articles used during Experiment I.

Corn meal, per ton,	$24 00
Wheat bran, per ton,	19 00
Gluten meal, per ton,	25 00
Buttermilk, per gallon,	1 cent.
Skim-milk, per gallon,	1 8 cents.

Valuation of essential fertilizing constituents in the above articles of fodder used: Nitrogen, 17 cents; phosphoric acid, 6 cents; potassium oxide, 4½ cents per pound.

	Corn Meal.	Wheat Bran.	Gluten Meal.	Butter-milk.	Skim-milk.
Moisture,	12.39	11.52	8.48	93.34	89.78
Nitrogen,	1.466	2.600	5.358	.391	.520
Phosphoric acid,	.707	2.870	.425	.135	.190
Potassium oxide,	.435	1.620	.045	.143	.200
Valuation per 2,000 pounds,	$6 22	$13 74	$19 13	$1 62	$2 18

Summary of Experiment II. (Nov. 18, 1890, to April 19, 1891).

	Corn Meal (Pounds).	Skim-milk (Quarts).	Wheat Bran (Pounds).	Gluten Meal (Pounds).	Live Weight gained during Experiment.	Dressed Weight gained during Experiment.	Cost per Pound of Dressed Pork (Cents).
Berkshire, No. 1,	159.54	511.00	43.80	60.49	136.50	112.77	5.19
Berkshire, No. 2,	149.08	511.00	35.65	50.46	129.50	105.14	5.20
Poland China, No. 1,	223.54	488.50	69.96	84.96	157.00	132.35	5.50
Poland China, No. 2,	170.68	491.00	48.94	63.75	114.00	95.73	6.28
Small Yorkshire, No. 1,	215.40	515.00	60.01	71.82	151.75	127.11	5.53
Small Yorkshire, No. 2,	218.84	515.00	63.70	82.26	146.00	123.56	5.84

Local Market Value of the Various Articles of Fodder used during Experiment II.

Corn meal, per ton,	$27 00
Skim-milk, per gallon,	1.8 cents.
Wheat bran, per ton,	$25 00
Gluten meal, per ton,	28 00

Valuation of essential fertilizing constituents of the above fodder articles: Nitrogen, 15 cents; phosphoric acid, 5½ cents; potassium oxide, 4½ cents per pound.

	Corn Meal.	Skim-milk.	Wheat Bran.	Gluten Meal.
Moisture,	13.26	89.78	12.11	10.90
Nitrogen,	1.796	.520	2.599	4.959
Phosphoric acid,	.707	.190	2.845	.425
Potassium oxide,	.435	.200	1.625	.045
Valuation per 2,000 pounds,	$6 56	$1 95	$12 39	$15 38

Summary of Experiment III. (May 12 to Sept. 7, 1891).

	Corn Meal (Pounds).	Skim-milk (Quarts).	Wheat Bran (Pounds).	Gluten Meal (Pounds).	Live Weight gained during Experiment.	Dressed Weight gained during Experiment.	Cost per Pound of Dressed Pork (Cents).
Berkshire, No. 1, ...	237.70	631.00	80.46	105.07	177.50	142.96	6.20
Berkshire, No. 2, ...	221.66	631.00	70.82	94.51	169.25	141.04	5.93
Small Yorkshire, No. 1, . .	215.60	680.00	53.45	67.93	156.00	126.86	6.25
Small Yorkshire, No. 2, . .	268.53	794.00	58.68	73.16	174.00	145.36	6.46
Poland China, No. 1, . . .	208.44	589.00	59.29	75.16	171.50	136.61	5.54
Poland China, No. 2, . . .	204.31	589.00	61.10	74.42	156.50	124.77	6.03
Tamworth, No. 1, ...	210.07	510.00	73.24	92.38	143.00	126.33	6.06
Tamworth, No. 2, ...	206.57	510.00	72.46	91.73	141.75	114.90	6.59

Local Market Value of the Various Articles of Fodder used during Experiment III.

Corn meal, per ton, ...	$31 00
Skim-milk, per gallon, ...	1.8 cents.
Wheat bran, per ton, ...	$23 00
Gluten meal, per ton, ...	27 00

Valuation of the essential fertilizing constituents of the above fodder articles: Nitrogen, 15 cents; phosphoric acid, 5½ cents; potassium oxide, 4½ cents per pound.

	Corn Meal.	Skim-milk.	Wheat Bran.	Gluten Meal.
Moisture, ...	15.31	91.18	12.99	11.11
Nitrogen, ...	1.651	.445	2.249	4.741
Phosphoric acid, ...	.693	.163	2.793	.413
Potassium oxide, ...	.426	.172	1.592	.044
Valuation per 2,000 pounds, . .	$6 10	$1 67	$11 25	$14 72

Summary of the Three Feeding Experiments, regarding the Character and Quantity of Feed consumed per Pound of Live Weight and Dressed Weight produced.

I. May to October, 1890.

BREED.	Number of Animals on Trial.	Nutritive Ratio, Period I.	Nutritive Ratio, Period II.	Nutritive Ratio, Period III.	Dry Matter consumed per Pound of Live Weight (Pounds).	Dry Matter consumed per Pound of Dressed Weight (Pounds).
Small Yorkshire, ...	2	1:2.79	1:3.90	1:4.49	2.82	3.32
Berkshire, ...	3	1:2.82	1:3.85	1:4.47	2.69	3.31
Poland China, ...	1	1:2.76	1:3.84	1:4.50	2.67	3.20
Tamworth, ...	2	1:2.85	1:3.85	1:4.48	2.50	3.13
II. November, 1890, to April, 1891.						
Small Yorkshire, ...	2	1:2.88	1:3.80	1:4.38	2.87	3.42
Berkshire, ...	2	1:2.89	1:3.76	1:4.35	2.49	3.04
Poland China, ...	1	1:2.85	1:3.74	1:4.39	2.80	3.32
Tamworth, ...	–	–	–	–	–	–
III. May to September, 1891.						
Small Yorkshire, ...	2	1:3.14	1:4.19	1:4.80	2.77	3.36
Berkshire, ...	2	1:3.13	1:4.22	1:4.89	2.71	3.31
Poland China, ...	2	1:3.14	1:4.23	1:4.90	2.49	3.12
Tamworth, ...	2	1:3.12	1:4.26	1:4.93	2.94	3.48

Summary of the Three Feeding Experiments, regarding Gain in Weight, Cost of Feed and Rate of Shrinkage of Pork dressed for the Market.

BREED.	Number of Animals on Trial.	Average Live Weight of Animals on Trial at Beginning.	Average Live Weight of Animals at Time of Killing.	Number of Days on Trial.	Average Gain in Live Weight during Experiment (Pounds).	Average Gain in Live Weight per Day (Pounds).	Average Cost of Feed per Pound of Dressed Pork (Cents).	Average Shrinkage in Weight by Dressing (Per Cent.).
I.								
Small Yorkshire, .	2	26.80	212.10	156	185.60	1.19	4.79	15.09
Berkshire, . .	3	21.50	192.00	142	170.70	1.20	4.80	18.87
Poland China, .	1	26.25	241.75	156	215.50	1.38	4.57	16.44
Tamworth, . .	2	22.75	199.90	128	177.00	1.38	4.52	20.01
II.								
Small Yorkshire, .	2	47.38	196.20	148	148.80	1.01	5.19	15.80
Berkshire, . .	2	21.12	154.12	148	133.0	0.90	4.80	18.01
Poland China, .	1	46.00	207.00	141	157.0	1.11	4.98	15.87
Tamworth, . .	–	–	–	–	–	–	–	–
III.								
Small Yorkshire, .	2	26.25	191.25	144.5	165.0	1.15	5.61	17.57
Berkshire, . .	2	24.12	197.50	128	173.4	1.35	5.32	18.06
Poland China, .	2	23.60	187.60	119	163.5	1.38	5.09	20.37
Tamworth, . .	2	39.60	182.00	100	142.3	1.42	5.52	15.30

Basis of valuation per ton: Corn meal, $24; wheat bran, $19; gluten meal, $25; skim-milk, per gallon, 1.8 cents; buttermilk, per gallon, 1.0 cent.

Summary of Cost of Feed consumed for the Production of One Pound of Dressed Pork, based on the Ruling Market Price of the Fodder Articles when used.

BREED.	EXPERIMENT I.			EXPERIMENT II.			EXPERIMENT III.		
	Total Cost.	Net Cost.	Obtainable Manurial Value.	Total Cost.	Net Cost.	Obtainable Manurial Value.	Total Cost.	Net Cost.	Obtainable Manurial Value.
	Cents.	Cents	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
Small Yorkshire, . . .	4.79	3.14	1.65	5.68	4.14	1.54	6.36	4.86	1.50
Berkshire, ...	4.80	3.13	1.67	5.20	3.74	1.46	6.07	4.59	1.48
Poland China, . . .	4.57	2.98	1.59	5.50	4.00	1.50	5.79	4.40	1.39
Tamworth, ...	4.52	2.97	1.55	–	–	–	6.33	4.78	1.55

Local Market Cost of the Various Articles of Fodder used during the Three Experiments.

	Experiment I.	Experiment II.	Experiment III.
Corn meal, per ton, . .	$24 00	$27 00	$31 00
Wheat bran, per ton, . .	19 00	25 00	23 00
Gluten meal, per ton, . .	25 00	28 00	27 00
Buttermilk, per gallon, . .	0 01	–	–
Skim-milk, per gallon, . .	0 018	0 018	0 018

Relative Cost of Feed per Pound of Dressed Pork (Cents), based on the Lowest and Highest Market Price.

	I.	II.
Corn meal, per ton, ...	$24 00	$31 00
Wheat bran, per ton, ...	19 00	23 00
Gluten meal, per ton, ...	25 00	27 00
Skim-milk, per gallon, ...	1.8 cents.	1.8 cents.
Buttermilk, per gallon, ...	1.0 cent.	1.0 cent.

	Experiment I.	Experiment II.	Experiment III.
I.			
	Cents.	Cents.	Cents.
Small Yorkshire, No. 1, . .	4.79	5.04	5.53
Small Yorkshire, No. 2, . .		5.34	5.68
Berkshire, No. 1, . . .	4.80	4.78	5.43
Berkshire, No. 2, . . .		4.81	5.21
Berkshire, No. 3, . . .		–	–
Poland China, No 1, . .	4.57	4.98	4.87
Poland China, No. 2, . .	–	–	5.30
Tamworth, No. 1, . . .	4.52	–	5.28
Tamworth, No. 2, . . .		–	5.76
II.			
Small Yorkshire, No. 1, . .	5.58	5.80	6.25
Small Yorkshire, No. 2, . .		5.30	6.46
Berkshire, No. 1, . . .	5.57	5.40	6.20
Berkshire, No. 2, . . .		5.42	5.93
Berkshire, No. 3, . . .		–	–
Poland China, No. 1, . .	5.33	5.75	5.54
Poland China, No. 2, . .	–	–	6.03
Tamworth, No. 1, . . .	5.26	–	6.06
Tamworth, No. 2, . . .		–	6.59

Conclusions.

1. *The average amount of dry matter consumed* per pound of dressed pork produced differs for different breeds as follows: First experiment, in case of Tamworths and Poland Chinas, from 3.13 to 3.20 pounds; in case of Berkshires and Small Yorkshires, from 3.31 to 3.32 pounds. Second experiment, in case of Berkshires and Small Yorkshires, from 3.04 to 3.42 pounds; Poland Chinas, 3.32 pounds; Tamworths ruled out, on account of sickness in the second experiment. Third experiment, in case of Poland Chinas and Tamworths, from 3.12 to 3.48 pounds; and in case of Berkshires and Small Yorkshires, from 3.31 to 3.36 pounds. Summing up the results of the three experiments in this connection, it appears that in our case the larger build breeds lead the smaller breeds in two out of three cases. The difference between breeds is apparently not more marked than the difference between animals of the same breed.

2. *The average gain in live weight per day* differs in the first trial, between Small Yorkshires and Berkshires, from

1.19 to 1.20 pounds; Poland Chinas and Tamworths are even, 1.38 pounds; in the second experiment, Small Yorkshires 1.01 to Berkshires .9 pounds; Poland Chinas 1.01 pounds; in the third experiment, Small Yorkshires 1.15, Berkshires 1.35, Poland Chinas 1.38 and Tamworths 1.42 pounds. The Berkshires lead the Small Yorkshires in two out of three experiments, while the Poland Chinas and Tamworths show practically no difference in that respect.

3. *The cost of feed per pound of dressed pork produced* varies in case of different breeds in the successive experiments as follows: First experiment, Small Yorkshires and Berkshires, from 4.79 to 4.80 cents, and Tamworths and Poland Chinas 4.52 to 4.57 cents; second experiment, Berkshires and Small Yorkshires 4.80 to 5.19 cents, Poland Chinas 4.98 cents; third experiment, Berkshires and Small Yorkshires from 5.32 to 5.61 cents, and Poland Chinas and Tamworths from 5.09 to 5.52 cents. The Berkshires lead the Small Yorkshires in two out of three trials, and the Poland Chinas and Tamworths compare well with each other in two trials. The cost of feed in the previous statement is based on the contemporary market price of the different grain feeds, which during the third experiment were exceptionally high, as may be seen from previous reports.

4. The average net cost of the feed consumed per pound of dressed pork produced, allowing a loss of 30 per cent. of the essential manurial constituents of the feed consumed, compares as follows: First experiment, Small Yorkshires, 3.14 cents; Berkshires, 3.13 cents; Poland Chinas, 2 98 cents; Tamworths, 2.92 cents. Second experiment, Small Yorkshires, 4.14 cents; Berkshires, 4.70 cents; Poland Chinas, 4.00 cents. Third experiment, Small Yorkshires, 4.86 cents; Berkshires, 4.59 cents; Poland Chinas, 4.40 cents; and Tamworths, 4.78 cents. The value of the obtainable manure averages in the first experiment, per pound of dressed pork sold, 1.61 cents; second experiment, 1.50 cents; and in the third experiment, 1.48 cents, — which is equal to from one-quarter to one-third of the total cost of the feed consumed. The commercial value of the manurial constituents of the feed consumed during our three feeding experiments amounts to $12.39, of which from eight to nine dollars' worth may be saved.

Detailed Statement of Third Experiment.

Small Yorkshire, No. 1 (Experiment III.).

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period (Pounds).
1891.								
April 28 to June 22, .	37.88	303.00	14.48	28.96	1:3.14	26.00	83.25	1.02
June 23 to July 27, .	63.53	175.00	19.75	19.75	1:4.19	83.25	127.00	1.25
July 28 to Sept. 7, .	114.19	202.00	19.22	19.22	1:4.82	127.00	182.00	1.31

Total Amount of Feed consumed from April 28 to Sept. 7, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
215.60 pounds corn meal, . . .	182.59	$3 34	$0 66
680.00 quarts skim-milk, . . .	130.14	3 06	1 23
53.45 pounds wheat bran, . .	46.51	0 61	0 30
67.93 pounds gluten meal, . .	60.38	0 92	0 50
	419.62	$7 93	$2 69

	Pounds.
Live weight of animal at beginning of experiment, ...	26.00
Live weight at time of killing, ...	182.00
Live weight gained during experiment, ...	156.00
Dressed weight at time of killing, ...	148.00
Loss in weight by dressing, . . . 34 pounds, or 18.68 per cent.	
Dressed weight gained during experiment, ...	126.86

2.69 pounds of dry matter fed yielded 1 pound of live weight, and 3.31 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.25 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent. of the manurial value of the feed, 4.77 cents.

Detailed Statement of Third Experiment — Continued.

Small Yorkshire, No. 2 (Experiment III.)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1891.								
April 28 to June 22,	37.88	303.00	14.48	28.96	1:3.14	26.50	77.75	0.92
June 23 to July 27,	63.50	175.00	19.75	19.75	1:4.19	77.75	119.50	1.19
July 28 to Sept. 30,	167.15	316.00	24.45	24.45	1:4.78	119.50	200.50	1.25

Total Amount of Feed consumed from April 28 to Sept. 30, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
268.53 pounds corn meal,	227.42	$4 16	$0 82
794.00 quarts skim-milk,	151.97	3 57	1 44
58.68 pounds wheat bran,	51.06	0 67	0 33
73.16 pounds gluten meal,	65.03	0 99	0 54
	495.48	$9 39	$3 13

	Pounds.
Live weight of animal at beginning of experiment,	26.50
Live weight at time of killing,	200.50
Live weight gained during experiment,	174.00
Dressed weight at time of killing,	167.50
Loss in weight by dressing,	33 pounds, or 16.46 per cent.
Dressed weight gained during experiment,	145.36

2.85 pounds of dry matter fed yielded 1 pound of live weight, and 3.41 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.46 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent. of manurial value of feed, 4.95 cents.

Detailed Statement of Third Experiment — Continued.

Berkshire, No. 1 (Experiment III.).

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1891.								
May 26 to July 20, . .	34.25	280.00	24.61	49.22	1:3.12	25.50	88.50	1.13
July 21 to Aug. 17, . .	53.63	132.00	21.88	21.88	1:4.23	88.50	129.00	1.45
Aug. 18 to Sept. 30, . .	149.82	219.00	33.97	33.97	1:4.91	129.00	203.00	1.72

Total Amount of Feed consumed from May 26 to Sept. 30, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
237.70 pounds corn meal, . . .	201.31	$3 68	$0 72
631.00 quarts skim-milk, . . .	120.77	2 84	1 14
80.46 pounds wheat bran, . .	70.01	0 93	0 45
105.07 pounds gluten meal, . .	93.40	1 42	0 77
	485.49	$8 87	$3 08

	Pounds.
Live weight of animal at beginning of experiment, . . .	25.50
Live weight at time of killing, ...	203.00
Live weight gained during experiment, ...	177.50
Dressed weight at time of killing, ...	163.50
Loss in weight by dressing, . .	39½ pounds, or 19.46 per cent.
Dressed weight gained during experiment, ...	142.96

2.74 pounds of dry matter fed yielded 1 pound of live weight, and 3.40 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.20 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent. of the manurial value of the feed, 4.69 cents.

Detailed Statement of Third Experiment — Continued.

Berkshire, No. 2 (Experiment III).

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1891.								
May 26 to July 20, . .	35.00	280.00	23.69	47.38	1:3.13	22.75	85.50	1.12
July 21 to Aug. 17, . .	52.25	132.00	20.87	20.87	1:4.21	85.50	121.50	1.29
Aug. 18 to Sept. 30, . .	134.41	219.00	26.26	26.26	1:4.86	121.50	192.00	1.60

Total Amount of Feed consumed from May 26 to Sept. 30, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
221.66 pounds corn meal, . . .	187.72	$3 44	$0 68
631.00 quarts skim-milk, . . .	120.77	2 84	1 14
70.82 pounds wheat bran, . .	61.62	0 81	0 40
94.51 pounds gluten meal, . .	84.01	1 28	0 70
	454.12	$8 37	$2 92

	Pounds.
Live weight of animal at beginning of experiment, . .	22.75
Live weight at time of killing, ...	192.00
Live weight gained during experiment, ...	169.25
Dressed weight at time of killing, ...	160.00
Loss in weight by dressing, . . . 32 pounds, or 16.67 per cent.	
Dressed weight gained during experiment, ...	141.04

2.68 pounds of dry matter fed yielded 1 pound of live weight, and 3.22 pounds of dry matter yielded 1 pound dressed weight.

Cost of feed for production of 1 pound of dressed pork, 5.93 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent. of the manurial value of the feed, 4.49 cents.

Detailed Statement of Third Experiment — Continued.

Poland China, No. 1 (Experiment III.).

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1891.								
May 12 to July 6, . .	35.25	282.00	15.88	31.75	1:3.14	23.75	90.00	1.18
July 7 to July 27, . .	41.88	105.00	15.63	15.63	1:4.23	90.00	122.00	1.52
July 28 to Sept. 7, . .	131.31	202.00	27.78	27.78	1:4.89	122.00	195.25	1.74

Total Amount of Feed consumed from May 12 to Sept. 7, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
208.44 pounds corn meal, . . .	176.53	$3 23	$0 64
589.00 quarts skim-milk, . . .	112.73	2 65	1 07
59.29 pounds wheat bran, . .	51.59	0 68	0 33
75.16 pounds gluten meal, . .	66.81	1 01	0 55
	407.66	$7 57	$2 59

	Pounds.
Live weight of animal at beginning of experiment, . .	23.75
Live weight at time of killing, ...	195.25
Live weight gained during experiment, ...	171.50
Dressed weight at time of killing, ...	155.50
Loss in weight by dressing, . .	40 pounds, or 20.46 per cent.
Dressed weight gained during experiment, ...	136.61

2.38 pounds dry matter fed yielded 1 pound live weight, and 2.98 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 5.54 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent. of manurial value of feed, 4.22 cents.

Detailed Statement of Third Experiment — Continued.

Poland China, No. 2 (Experiment III.).

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-Milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1891.								
May 12 to July 6, . .	35.25	282.00	13.31	26.63	1:3.14	23.50	77.50	0.96
July 7 to Aug. 3, . .	56.13	140.00	22.38	22.38	1:4.23	77.50	121.50	1.57
Aug. 4 to Sept. 7, . .	112.93	167.00	25.41	25.41	1:4.91	121.50	180.00	1.67

Total Amount of Feed consumed from May 12 to Sept. 7, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
204.31 pounds corn meal, . . .	173.03	$3 17	$0 62
589.00 quarts skim-milk, . . .	112.73	2 65	1 07
61.10 pounds wheat bran, . .	53.16	0 70	0 34
74.42 pounds gluten meal, . .	66.15	1 00	0 55
	405.07	$7 52	$2 58

	Pounds.
Live weight of animal at beginning of experiment, . . .	23.50
Live weight at time of killing, ...	180.00
Live weight gained during experiment, ...	156.50
Dressed weight at time of killing, ...	143.50
Loss in weight by dressing, . . . 36½ pounds, or 20.28 per cent.	
Dressed weight gained during experiment, ...	124.77

2.59 pounds of dry matter fed yielded 1 pound of live weight, and 3.25 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.03 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent. of manurial value of feed, 4.58 cents.

Detailed Statement of Third Experiment — Continued.

Tamworth, No. 1 (Experiment III.).

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1891.								
May 5 to June 8, . .	24.50	196.00	19.15	38.29	1:3.12	41.50	90.00	1.39
June 9 to July 6, . .	58.00	140.00	23.00	23.00	1:4.25	90.00	123.50	1.20
July 7 to Aug. 12, . .	127.57	174.00	31.09	31.09	1:4.94	123.50	184.50	1.65

Total Amount of Feed consumed from May 5 to Aug. 12, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
210.07 pounds corn meal, . . .	177.91	$3 26	$0 64
510.00 quarts skim-milk, . . .	97.61	2 30	0 92
73.24 pounds wheat bran, . .	63.73	0 84	0 41
92.38 pounds gluten meal, . .	82.12	1 25	0 68
	421.37	$7 65	$2 65

	Pounds.
Live weight of animal at beginning of experiment, . . .	41.50
Live weight at time of killing, ...	184.50
Live weight gained during experiment, ...	143.00
Dressed weight at time of killing, ...	163.00
Loss in weight by dressing, . . 21½ pounds, or 11.65 per cent.	
Dressed weight gained during experiment, ...	126.33

2.95 pounds of dry matter fed yielded 1 pound of live weight, and 3.34 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.06 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent. of manurial value of feed, 4.58 cents.

Detailed Statement of Third Experiment — Continued.

Tamworth, No. 2 (Experiment III.).

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period (Pounds).
1891.								
May 5 to June 8, . .	24.50	196.00	19.27	38.54	1:3.12	37.75	85.50	1.36
June 9 to July 6, . .	59.69	140.00	24.69	24.69	1:4.26	85.50	122.50	1.32
July 7 to Aug. 12, . .	122.38	174.00	28.50	28.50	1:4.92	122.50	179.50	1.54

Total Amount of Feed consumed from May 5 to Aug. 12, 1891.

	Dry Matter (Pounds).	Cost.	Manurial Value.
206.57 pounds corn meal, . .	174.94	$3 20	$0 63
510.00 quarts skim-milk, . . .	97.61	2 30	0 92
72.46 pounds wheat bran, . .	63.05	0 83	0 41
91.73 pounds gluten meal, . .	81.54	1 24	0 68
	417.14	$7 57	$2 64

	Pounds.
Live weight of animal at beginning of experiment, . . .	37.75
Live weight at time of killing, ...	179.50
Live weight gained during experiment, ...	141.75
Dressed weight at time of killing, ...	145.50
Loss in weight by dressing, . . . 34 pounds, or 18.94 per cent.	
Dressed weight gained during experiment, ...	114.90

2.94 pounds of dry matter fed yielded 1 pound of live weight, and 3.63 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.59 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent of manurial value of feed, 4.98 cents.

Detailed Statement of Third Experiment — Concluded.

Summary of Gain in Weight (Experiment III.).

SUMMER, 1891.	Live Weight at Beginning (Pounds.)		Live Weight when Killed (Pounds).		Gain in Live Weight (Pounds).	
	No. 1.	No. 2.	No. 1.	No. 2.	No. 1.	No. 2.
Small Yorkshires,	26.00	26.50	182.00	200.50	156.00	174.00
Poland Chinas, .	23.75	23.50	195.25	180.00	171.50	156.50
Berkshires, . .	25.50	22.75	203.00	192.00	177.50	169.25
Tamworths, . .	41.50	37.75	184.50	179.50	143.00	141.75

SUMMER, 1891.	Number of Days of Feeding.		Gain in Live Weight per Day (Pounds).	
	No. 1.	No. 2	No. 1.	No. 2.
Small Yorkshires, . . .	133	156	1.17	1.12
Poland Chinas, . . .	119	119	1.44	1.32
Berkshires, ...	128	128	1.39	1.32
Tamworths, ...	100	100	1.43	1.42

Fodder Analyses.

Corn Meal (Experiment I.).

1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	12.39	247.80	–	–	1 : 9.70
Dry matter, . . .	87.61	1,752.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	1.80	36.00	–	–	
" cellulose, . . .	1.80	36.00	12.24	34	
" fat, ...	5.01	100.20	76.15	76	
" protein (nitrogenous matter), . .	10.46	209.20	177.82	85	
Non-nitrogenous extract matter, ...	80.93	1,618.60	1,521.48	94	
	100.00	2,000.00	1,787.69	–	

Fodder Analyses — Continued.

Wheat Bran (Experiment I.).

1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	11.52	230.40	–	–	1 : 3.71
Dry matter, . . .	88.48	1,769.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	7.13	142.60	–	–	
" cellulose, . . .	10.63	212.60	42.52	20	
" fat, ...	5.62	112.40	89.92	80	
" protein (nitrogenous matter), . .	18.36	367.20	323.14	88	
Non-nitrogenous extract matter, ...	58.26	1,165.20	932.16	80	
	100.00	2,000 00	1,387.74	–	

Gluten Meal (Experiment I.).

1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	8.48	169.60	–	–	1 : 2.22
Dry matter, . . .	91.52	1,830.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, ...	0.76	15.20	–	–	
" cellulose, . . .	0.68	13.60	4.62	34	
" fat, ...	11.14	222.80	169.33	76	
" protein (nitrogenous matter), . .	36.59	731.80	622.03	85	
Non-nitrogenous extract matter, ...	50.83	1,016.60	955.60	94	
	100.00	2,000.00	1,751.58	–	

Fodder Analyses — Continued.

Buttermilk (Experiment I.).

1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	93.34	1,866.80	–	–	1 : 1.72
Dry matter,	6.66	133.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	7.51	150.20	–	–	
" fat,	4.80	96.00	96.00	100	
" protein (nitrogenous matter),	36.64	732.80	732.80	100	
Non-nitrogenous extract matter,	51.05	1,021.00	1,021.00	100	
	100.00	2,000.00	1,849.80	–	

Skim-milk (Experiments I. and II.).

1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	89.78	1,795.60	–	–	
Dry matter,	10.22	204.40	–	–	1 : 2.13
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.85	137.00	–	–	
" fat,	3.82	76.40	76.40	100	
" protein (nitrogenous matter),	31.60	632.00	632.00	100	
Non-nitrogenous extract matter,	57.73	1,155.60	1,155.60	100	
	100.00	2,000.00	1,864.00	–	

Note. — The analysis of the grain feed used during the second experiment is the same as of these articles stated in connection with the preceding corn-feeding experiment for the same period of time.

Fodder Analyses — Continued.

Corn Meal (Experiment III.).

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	15.31	303.20	–	–	1 : 9.23
Dry matter, . . .	84.69	1,697.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, . . .	1.72	34.40	–	–	
" cellulose, . . .	2.17	43.40	20.83	48	
" fat, ...	4.84	96.80	82.28	85	
" protein (nitrogenous matter), . .	12.18	243.60	192.44	79	
Non-nitrogenous extract matter, ...	79.09	1,581.80	1,550.16	98	
	100.00	2,000.00	1,845.71	–	

Wheat Bran (Experiment III.).

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	12.99	259.80	–	–	1 : 4.73
Dry matter, . . .	87.01	1,740.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash, . . .	6.23	124.60	–	–	
" cellulose, . . .	10.47	209.40	50.26	24	
" fat, . . .	5.37	107.40	76.25	71	
" protein (nitrogenous matter), . .	16.16	323.20	252.10	78	
Non-nitrogenous extract matter, ...	61.77	1,235.40	951.26	77	
	100.00	2,000.00	1,329.87	–	

Fodder Analyses — Concluded.

Gluten Meal (Experiment III.).

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	11.11	222.20	–	–	1 : 2.66
Dry matter,	88.89	1,777.80	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	1.65	33.00	–	–	
" cellulose,	0.73	14.60	9.05	62	
" fat,	9.22	184.40	156.74	85	
" protein (nitrogenous matter),	33.34	666.80	526.77	79	
Non-nitrogenous extract matter,	55.06	1,101.20	1,002.09	91	
	100.00	2,000.00	1,694.65	–	

Skim-milk (Experiment III.).

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	91.18	1,823.60	–	–	1 : 2.16
Dry matter,	8.82	176.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude ash,	6.80	136.00	–	–	
" fat,	4.20	84.00	84.00	100	
" protein (nitrogenous matter),	31.52	630.40	630.40	100	
Non-nitrogenous extract matter,	57.48	1,149.60	1,149.60	100	
	100.00	2,000.00	1,864.00	–	

PART II.

ON

FIELD EXPERIMENTS

AND

OBSERVATIONS IN VEGETABLE PHYSIOLOGY

AND

PATHOLOGY.

1. Effect of Different Kinds of Nitrogen-containing Manurial Substances on the Yield of Rye (Field A).
2. Experiments with Prominent Varieties of Grasses and with Grass Mixtures, to ascertain their Comparative Economical Value under fairly Corresponding Circumstances (Field B).
3. Experiments with Reputed Fodder Crops mostly new to our Locality, and with a Series of Garden Crops treated with Different Mixtures of Commercial Fertilizing Ingredients (Field C).
4. Experiment with raising Stowell's Evergreen Sweet Corn for Ensilage (Field D).
5. Experiments with Different Commercial Phosphates, to study the Economy of using Natural Phosphates or Acidulated Phosphates in Farm Practice (Field F).
6. Experiments with a Western Variety of Dent Corn, Pride of the North, for Ensilage (Field G).
7. Experiments with Grass Lands (Meadows).
8. Report on General Farm Work in 1891.
9. Report of Prof. James Ellis Humphrey on Plant Diseases, etc., with Observations in the Field and in the Vegetation House.

1. FIELD EXPERIMENT TO ASCERTAIN THE EFFECT OF DIFFERENT COMBINATIONS OF NITROGEN — I. E., SODIUM NITRATE, CHILI SALTPETRE, AMMONIUM SULPHATE AND NITROGEN-CONTAINING ORGANIC MATTER, UNDER OTHERWISE CORRESPONDING CIRCUMSTANCES — ON RYE (1891).

Field A.

The well-authenticated and unbroken record of this field extends over more than twenty years. The systematic treatment of the soil, as far as modes of cultivation and of manuring are concerned, was introduced during the season of 1883–84. The subdivision of the entire area into eleven plats (one-eighth of an acre each) of a uniform size and shape, one hundred and thirty feet long and thirty feet wide, with an unoccupied and unmanured space of five feet in width between adjoining plats, has been retained unaltered since 1884. A detailed statement of the particular aim and general management of our experiments, as well as of the results obtained in that connection, from year to year forms a prominent part of our contemporary printed annual reports, to which I have to refer for details.

The most conspicuous result of the field experiments carried on upon Field A during the years 1884 to 1888 consists in the very striking illustration of a marked deficiency of the soil on trial on available potash, as compared with other essential articles of plant food.

Since 1889 the main object of observations upon the same field has been to study the influence of both an entire exclusion of any additional nitrogen-containing manurial substance from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination, on the character and yield of the crop selected for the trial. The treatment of the soil adopted in preceding years favored this new project for field observations.

Several plats which for five preceding years did not receive any nitrogen compound for manurial purposes were retained in that state, to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation, while the remaining ones received as before a definite amount of nitrogen in the same form in which they had received it in preceding years: namely, either as sodium nitrate or as ammonium sulphate, or as organic nitrogenous matter in form of dried blood. A corresponding amount of available nitrogen was applied in all these cases.

Aside from the difference regarding the nitrogen supply, all plats were treated alike. They each received without an exception a corresponding amount of available phosphoric acid and of potassium oxide. The phosphoric acid was supplied, in form of dissolved bone-black, and the potassium oxide either in form of muriate of potash or of potash-magnesia sulphate. From 120 to 130 pounds of potassium oxide, from 80 to 85 pounds of available phosphoric acid and from 40 to 50 pounds of available nitrogen were supplied per acre.

One plat marked 0 received its main supply of phosphoric acid, potassium oxide and nitrogen in form of barn-yard manure; the latter was carefully analyzed before being applied, to determine the amount required to secure, as far as practicable, the desired corresponding proportion of essential fertilizing constituents. The deficiency in potassium oxide and phosphoric acid was supplied by potash-magnesia sulphate and dissolved bone-black. The fertilizer for this plat consisted of 800 pounds of barn-yard manure, 32 pounds of potash-magnesia sulphate and 18 pounds of dissolved bone-black.

The mechanical preparation of the soil, the incorporation of the manurial substances, — the general character of the latter being the same, — the seeding, cultivating and harvesting were carried on year after year in a like manner, and as far as practicable on the same day in case of every plat during the same year.

This course in the general management of the experiment has been followed thus far for three successive years — 1889, 1890 and 1891 — in connection with different crops: —

Corn (maize), in 1889 (see seventh annual report); oats, in 1890 (see eighth annual report); rye, in 1891 (see ninth annual report).

The following tabular statement shows the annual application and special distribution of the manurial substances with reference to each plat since 1889. The fertilizers were in every case applied broadcast as early as circumstances permitted. They were slightly harrowed under before the seed was planted in rows by a seed drill. Each plat received the same amount of seed.

NUMBER OF PLAT.	Annual Supply of Manurial Substances.
Plat 0, .	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

1891. — The soil of the field being brought by ploughing and harrowing into a good mechanical condition for planting, the entire area was seeded with winter rye Sept. 5, 1890. Each plat received five and one-half pounds of rye in drills two feet apart. The second largest plate was used in the seeding machine.

The young plants appeared above ground October 1. The growth upon Plat 6 and on 8 in particular presented soon after a yellowish-green appearance; otherwise the crop promised well.

The late winter season was somewhat unfavorable to winter crops, — a fact noticed quite generally in our vicinity on grass lands. The rye crop showed signs of winter-killing; the growth upon Plat 2 had apparently suffered more than that on any other plat. The following tabular record shows the rate of growth upon the different plats at different periods of the season, — May 12 to June 16: —

	May 12.	May 19.	May 27.	June 2.	June 10.	June 16.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Plat 0, . .	19	26	42	61	65	66
Plat 1, . .	21	27	44	60	66	66
Plat 2, . .	21	27	44	60	65	66
Plat 3, . .	21	27	46	63	67	67
Plat 4, . .	17	24	40	58	65	65
Plat 5, . .	19	23	40	59	64	66
Plat 6, . .	8	16	32	50	64	65
Plat 7, . .	20	26	46	60	68	68
Plat 8, . .	6	14	30	44	55	58
Plat 9, . .	19	28	40	61	66	66
Plat 10, . .	22	27	47	62	67	67

The differences noticeable in the above table regarding the rate of growth upon different plats are not less marked than were the variations in the color of the vegetation upon different plats at different stages of the season. The growth upon plats 4, 7, 10, and in particular 9, was of a light-green color; while upon plats 1 and 2 it was of a marked deep-green shade. This feature in the appearance of the vegetation over the entire area was quite marked during the entire season until the crop began to mature. Plats 4, 7 and 9 turned yellow, while plats 1, 2, 5, 6 and 8 were still green (July 9). The entire crop was cut July 16, and carried into the barn July 18. The subsequent tables show the difference in moisture of the crop from different plats when carried into the barn, as compared with a more uniform condition in that direction after two months' storing in the barn: —

	Weight when Harvested (July 18, 1891).	Weight when Threshed (Sept. 22, 1891).	Loss of Moisture.
	Pounds.	Pounds.	Per Cent.
Plat 0,	695	470	32.37
Plat 1,	790	570	27.85
Plat 2,	700	525	25.00
Plat 3,	605	475	21.49
Plat 4,	490	390	20.41
Plat 5,	660	530	19.70
Plat 6,	505	400	20.79
Plat 7,	495	450	9.09
Plat 8,	–	–	–
Plat 9,	495	425	14.14
Plat 10,	520	425	18.27

Plat 8 is excluded from the statement on account of a partial destruction of the crop by insects. The total yield of straw and grain obtained from different plats varies from 390 to 570 pounds in weight.

The relation of the grain to the straw and chaff will be found in the statement below : —

	Grain and Straw.	Grain.	Straw and Chaff.	Percentage of Grain.	Percentage of Straw and Chaff.
	Pounds.	Pounds.	Pounds.		
Plat 0,	470	142	328	30.21	69.79
Plat 1,	570	154	416	27.02	72.98
Plat 2,	525	134	391	25.52	74.48
Plat 3,	475	130	345	27.37	72.63
Plat 4,	390	107	283	27.44	72.56
Plat 5,	530	145	385	27.36	72.64
Plat 6,	400	102	298	25.50	74.50
Plat 7,	450	109	341	24.22	75.78
Plat 8,	–	–	–	–	–
Plat 9,	425	109	316	25.65	74.35
Plat 10,	425	125	300	29.41	70.59
	4,875	1,303	3,572	–	–

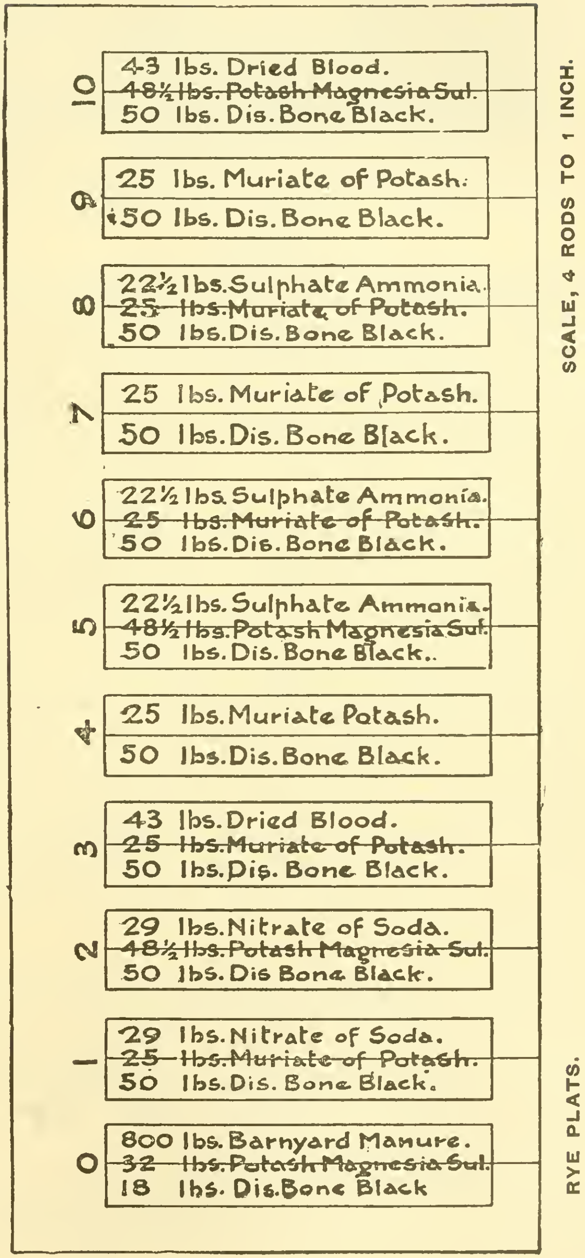
The yield of the grain for the entire field in case of the air-dry crop averages 26.72 per cent. and that of the straw and chaff 73.28 per cent. The yield of the grain upon different plats varies from 102 pounds to 154 pounds. Plat

2 differs in yield from Plat 1, probably on account of a more serious degree of winter-killing, as has been stated on a previous page. Plat 6 shows still the serious influence of several years' fallow (1885 to 1888), without the application of manure and without the cultivation of a crop (black fallow), on the productiveness of the soil thus treated. The low yield of grain (107 to 109 pounds) upon plats 4, 7 and 9, which did not receive any nitrogen-containing manurial matter, is a very significant result. The belief in the beneficial influence of a liberal supply of nitrogen on the quantity and the quality of grain crops is evidently well sustained by the results of the above-described experiment.

Summary of Three Years' Observations upon Field A (1889–91).

Number of Plat.	MANURIAL MATTER APPLIED.	1889.	1890. Yield of Oats.			1891. Yield of Rye.				
		Yield of Dry Fodder Corn.	Crop (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.	Crop (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.	Yield of Grain (Pounds).	Yield of Straw (Pounds).
		Pounds.								
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash magnesia sulphate and 18 lbs. of dissolved bone-black, ...	-	315	38.10	61.90	470	30.21	69.79	142	328
Plat 1,	29 lbs. sodium nitrate (=4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (=12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (=8.5 lbs. available phosphoric acid),	648	362	35.36	64.64	570	27.02	72.98	154	416
Plat 2,	29 lbs. sodium nitrate (=4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (=12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (=8.5 lbs. available phosphoric acid), .	577	365	35.34	64.66	525	25.52	74.48	134	391
Plat 3,	43 lbs. dried blood (=5 to 6 lbs. nitrogen), 25 lbs muriate of potash (=12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (=8.5 lbs. available phosphoric acid), .	618	345	33.62	66.38	475	27.37	72.63	130	345
Plat 4,	25 lbs. muriate of potash (=12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (=8.5 lbs. available phosphoric acid), ...	381	260	34.61	63.39	390	27.44	72.56	107	283
Plat 5,	22.5 lbs. ammonium sulphate (=4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (=12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (=8.5 lbs. available phosphoric acid), ...	488	360	39.20	60.80	530	27.36	72.64	145	385
Plat 6,	22.5 lbs. ammonium sulphate (=4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (=12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (=8.5 lbs. available phosphoric acid),	542	385	32.21	67.79	400	25.50	74.50	102	298
Plat 7,	25 lbs. muriate of potash (=12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (=8.5 lbs. available phosphoric acid), ...	526	320	34.40	65.60	450	24.22	75.78	109	341
Plat 8,	22.5 lbs. ammonium sulphate (=4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (=12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (=8.5 lbs. available phosphoric acid), .	359	220	26.82	73.18	-	-	-	-	-
Plat 9,	25 lbs. muriate of potash (=12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (=8.5 lbs. available phosphoric acid).	476	290	34.83	65.17	425	25.65	74.35	109	316
Plat 10,	43 lbs. dried blood (=5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (=12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (=8.5 lbs. available phosphoric acid),	640	395	35.44	64.56	425	29.41	70.59	125	300

FIELD "A," 1891.


10
43 lbs. Dried Blood.
48½ lbs. Potash Magnesia Sul.
50 lbs. Dis. Bone Black.
9
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
8
22½ lbs. Sulphate Ammonia.
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
7
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
6
22½ lbs. Sulphate Ammonia.
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
5
22½ lbs. Sulphate Ammonia.
48½ lbs. Potash Magnesia Sul.
50 lbs. Dis. Bone Black.
4
25 lbs. Muriate Potash.
50 lbs. Dis. Bone Black.
3
43 lbs. Dried Blood.
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
2
29 lbs. Nitrate of Soda.
48½ lbs. Potash Magnesia Sul.
50 lbs. Dis Bone Black.
1
29 lbs. Nitrate of Soda.
25 lbs. Muriate of Potash.
50 lbs. Dis. Bone Black.
0
800 lbs. Barnyard Manure.
32 lbs. Potash Magnesia Sul.
18 lbs. Dis. Bone Black
SCALE, 4 RODS TO 1 INCH.
RYE PLATS.

2. FIELD EXPERIMENT WITH PROMINENT VARIETIES OF GRASSES, TO STUDY THEIR COMPOSITION UNDER FAIRLY CORRESPONDING CONDITIONS, AS FAR AS SOIL AND MANURE ARE CONCERNED, AND TO COMPARE THEIR ECONOMICAL VALUE WHEN RAISED BY THEMSELVES AS WELL AS IN CASE OF MIXTURES (1891).

Field B.

This field occupies an area of one and seven-tenths acres, and runs from north to south, nearly on a level. The soil consists of a somewhat sandy loam of several feet in depth. The systematic treatment of the area was inaugurated in 1884, when the present subdivision into eleven plats was first introduced. The plats are 175 feet long and 33 feet wide (5,775 square feet, or two-fifteenths of an acre), of a uniform shape, running from east to west, with a space of five feet between adjoining plats. The numbering begins at the north end with 11, and closes at the south end with 21. From 1884 to 1889 every alternate plat received annually the same kind and the same amount of fertilizer, — 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. Plats 11, 13, 15, 19 and 21 were annually manured as stated, and plats 12, 14, 16, 18 and 20 received no manurial matter of any description during that period (1884 to 1889). The space of five feet left between the different succeeding plats has been kept clean from any growth by a constant use of the cultivator, and received at no time any kind of manure.

The details of the work carried on upon Field B have been thus far reported from year to year in our annual reports. The chemical analyses of the crops raised upon this field, on account of the amount of work involved, have been quite frequently published in later bulletins or in annual reports of the succeeding year.

A material change in the above-stated management of the field was made in 1889, with reference to the previously unmanured plats, 12, 14, 16, 18 and 20; they were subsequently annually manured in exactly the same manner as the remaining plats, receiving per acre 600 pounds of fine-ground bone and 200 pounds of muriate of potash. The character of the crops raised upon the various plats since 1888 to date may be seen from the following tabular statement: —

PLATS.	1888.	1889.	1890.	1891.
Plat 11 (fertilized),	Kentucky blue-grass (*Poa pratensis*),	Kentucky blue-grass,	Kentucky blue-grass, sown Sept. 24, 1889,	Kentucky blue-grass, sown Sept. 24, 1889.
Plat 12 (unfertilized),	Kentucky blue-grass,	Kentucky blue-grass,	Kentucky blue-grass, sown Sept. 24, 1889,	Kentucky blue-grass, sown Sept. 24, 1889.
Plat 13 (fertilized),	Italian rye-grass, English rye-grass,	Red-cob ensilage corn,	Red top, sown Sept. 24, 1889,	English rye-grass, north, sown Sept. 29, 1889. Italian rye-grass, south, sown Sept. 29, 1889.
Plat 14 (unfertilized),	Italian rye-grass, English rye-grass,	Red-cob ensilage corn,	Red top, sown Sept. 24, 1889,	English rye-grass and red top sown Sept. 29, 1890.
Plat 15 (fertilized),	Soja bean (*Soja hispida*),	Bokhara clover (*Melilotus alba*), Sainfoin (*Onobrychis sativa*),	Bokhara clover, sown May 8, 1889, Sainfoin, sown May 8, 1889,	Herds grass and red top, sown April 23, 1890.
Plat 16 (unfertilized),	Soja bean,	Bokhara clover, Sainfoin,	Rhode Island bent (*Agrostis alba*), sown Sept. 25, 1889,	Italian rye-grass and red top, sown April 23, 1890.
Plat 17 (fertilized),	Meadow fescue,	Meadow fescue,	Meadow fescue, sown September, 1887,	Meadow fescue, sown September, 1887.
Plat 18 (unfertilized),	Alsike clover, Medium red clover,	Red-cob ensilage corn,	Meadow fescue, sown September, 1889,	Meadow fescue, sown Sept. 29, 1890.
Plat 19 (fertilized),	Alsike clover, Medium red clover,	Alsike clover, Medium red clover,	Herds grass, sown September, 1889,	Herds grass, sown Sept. 25, 1889.
Plat 20 (unfertilized),	Mammoth red clover, Alfalfa,	Red-cob ensilage corn,	Red top and herds grass mixed, sown September, 1889,	Herds grass and red top, sown Sept. 29, 1890.
Plat 21 (fertilized),	Mammoth red clover, Alfalfa,	Corn (variety, Clark),	Meadow fescue and herds grass, mixed, sown September, 1889,	Meadow fescue and red top, sown Sept. 29, 1890.

1891. — Previous to the year 1891 other crops than grasses have been cultivated upon some plats at times. Of late none but single grasses or mixtures of reputed grasses have been planted. The single grasses are raised as in previous years in rows two feet apart; grass mixtures are seeded down broadcast. The manure in case of single grasses is applied by hand between the rows, and is subsequently slightly ploughed in by means of a cultivator; in case of grass mixtures the manure is applied as top dressing early in the spring. In both cases the first manure is applied broadcast and ploughed under before seeding down the grass.

Plat 11, Kentucky blue-grass (*Poa pratensis*), sown Sept. 24, 1889, in rows. The grass looked well in the spring; the growth between the rows was removed with the cultivator and the hoe, to secure as far as practicable a clean crop. The grass began to bloom June 5, when 27 inches high; it was cut when the seed began freely to set (June 17).

Plat 12, Kentucky blue-grass (*Poa pratensis*), sown Sept. 24, 1889. The grass on this plat showed signs of winter-killing. The crop was cut June 17. The yield of both plats, 11 and 12, amounted to 260 pounds of hay (975 pounds per acre) when removed to the barn. This plat (12) was ploughed July 8, 1891, the sod thoroughly cut up with a wheel harrow, properly harrowed and seeded down Sept. 18, 1891, with a mixture of four pounds each of Kentucky blue-grass and red top. The grass was well above ground Sept. 28, 1891.

Plat 13, English rye-grass (*Lolium perenne*) and Italian rye-grass (*Lolium Italicum*), each occupying one-half of the plat. Both were sown in rows Sept. 29, 1890. The Italian rye-grass was in better condition at the beginning of the spring than the English rye-grass. The latter had suffered in a considerable degree from winter-killing. The winter-killed spots were re-seeded at an early date. Both grasses bloomed fairly June 18; they were cut June 24. The first cut of hay amounted to one hundred pounds in each case (1,500 pounds per acre). The second cut of the English rye-grass yielded 120 pounds (1,800 pounds per acre) August 18, while the Italian rye-grass yielded 90 pounds (1,350 pounds per acre).

Plat 14, a mixture of English rye-grass and of red top, equal weights, sown broadcast Sept. 29, 1890. The crop was cut June 24; red top was not yet in bloom. The first crop amounted to 355 pounds of hay (2,662 pounds per acre); the second cut, August 31, yielded 90 pounds of hay (675 pounds per acre).

Plat 15, herds grass (*Phleum pratense*) and red top (*Agrostis vulgaris*), sown broadcast April 23, 1890. The crop was to such an extent infested with shepherd's purse that no record of yield was kept. The growth upon the plat was mowed whenever the weeds showed themselves above the grasses, to ascertain whether a repeated cutting during the first season will free the plat from that particular trouble.

Plat 16, Italian rye-grass and red top, sown broadcast April 23, 1890. The growth upon this plat suffered from the same causes as the preceding plat, — namely, from shepherd's purse, — and from the seeding down of grasses during spring time. The seeding down of grass lands in the spring is known to be an objectionable practice. Our experiment is made to furnish an illustration in that direction, and also to point out if possible some remedies.

Plat 17, meadow fescue (*Festuca pratensis*), sown in rows two feet apart, Sept. 25, 1887. The crop looked healthy every way throughout the season. It was in bloom June 15, when 38 inches high. The first cut, June 16, amounted to 450 pounds of hay (3,375 pounds per acre); and the second cut, September 1, to 140 pounds (1,050 pounds per acre).

Plat 18, meadow fescue, sown in rows two feet apart, Sept. 29, 1890. The grass looked healthy and vigorous during the entire period of growth. It bloomed June 20 and was cut June 25. The first cut yielded 190 pounds of hay (1,425 pounds per acre); and the second cut, September 1, yielded 170 pounds (1,275 pounds per acre).

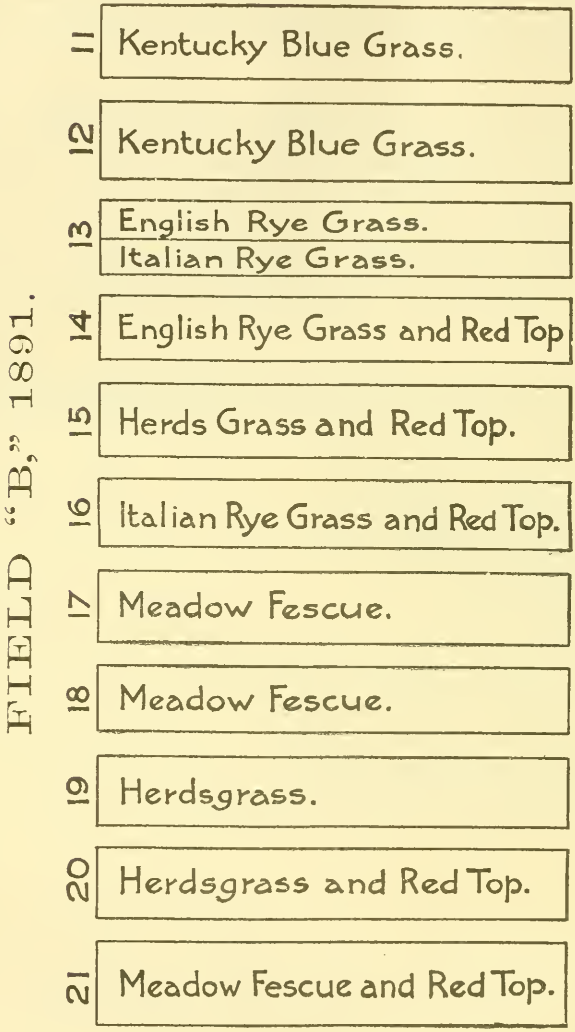
Plat 19, herds grass (*Phleum pratense*), sown in rows two feet apart, Sept. 25, 1889. The growth looked well throughout the season; it began to bloom June 25 and was cut July 1. The hay obtained weighed 630 pounds (4,725 pounds per acre).

Plat 20, mixture of herds grass and red top, sown broadcast Sept. 29, 1890. The herds grass was in bloom June 30; red top showed no flower at that time. The crop was cut July 1, and yielded 430 pounds of hay (3,225 pounds per acre).

Plat 21, meadow fescue (*Festuca pratensis*) and red top (*Agrostis vulgaris*), sown broadcast Sept. 29, 1890. The growth did not correspond to the seeds named. The first cut yielded, June 25, 650 pounds of hay (4,875 pounds per acre). The plat was ploughed, and the soil after thorough mechanical preparation was re-seeded September 18 with a mixture of four pounds of meadow fescue and four pounds of red top.

From the previous statements it will be seen that our present observation upon this field is confined to the following grasses and grass mixtures: —

Kentucky blue-grass.
English rye-grass.
Italian rye-grass.
Red top.
Herds grass.
Meadow fescue.
Kentucky blue-grass and red top.
English rye-grass and red top.
Italian rye-grass and red top.
Red top and herds grass.
Herds grass and meadow fescue.



FIELD "B," 1891.

11	Kentucky Blue Grass.
12	Kentucky Blue Grass.
13	English Rye Grass. Italian Rye Grass.
14	English Rye Grass and Red Top
15	Herds Grass and Red Top.
16	Italian Rye Grass and Red Top.
17	Meadow Fescue.
18	Meadow Fescue.
19	Herdsgrass.
20	Herdsgrass and Red Top.
21	Meadow Fescue and Red Top.

3. Experiments with Field and Garden Crops (1891).

Field C.

The area occupied by this piece of land is 328 feet long and 183 feet wide (60,024 square feet). The field is divided into two parts, running from west to east, making thus a north and south division, each 328 feet long and 90 feet wide, with three feet of unoccupied space between them. The soil consists of a good light loam, several feet in thickness. The manure annually applied during preceding years (1884–90) to the entire area consisted of 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The north division had been used for years for the raising of miscellaneous farm and garden crops, for the purpose of studying their adaptation to our clime. Upon the south division during the same period grain and leguminous crops were raised alternately, to serve as fodder.

1891. — Both divisions were ploughed during the preceding autumn, and again in the spring. The *north division* was manured at an early date with bone and potash, as in preceding years, — 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The fertilizer was applied broadcast, and subsequently ploughed in before harrowing and seeding.

The *south division* was subdivided into five plats of a uniform size and shape, with an unoccupied and unmanured space of from four to five feet between adjoining plats. Each plat running across the south division from north to south covered an area of sixty-two by eighty-eight feet. Each plat received a separate distinct mixture of fertilizing substances, to test the effect on the quality and quantity of different kinds of garden crops.

1. North Division, Field and Forage Crops.

The field was prepared and manured as above stated, and served as in preceding years for the cultivation of a variety of field crops. The work was instituted for the purpose of studying the acclimatization of a series of more or less reputed farm plants new to our section of the country, and also to serve as an object lesson to our visitors, regarding their general characteristics. The benefit derived from this practical illustration of our possibilities in the chöice of valuable additions to our field crops has been so manifest during preceding years that it will receive increased attention on our part in the future. Some of the plants here cultivated during previous seasons have already been introduced into our farm industry on a sufficiently extensive scale to enable us to form a decided opinion regarding their special local economical value. Foremost among them are some fodder crops, Southern cow-pea, serradella, some vetches, and black and white soja bean. Successful feeding experiments with green vetch and oats and with green soja bean, as well as with a mixed ensilage of soja bean and green fodder corn, have been already noted in our preceding report (eighth). The satisfactory results of preceding years were fully confirmed during the late summer season. A detailed description of this experiment may be found in this report, under the heading, "Summer Feeding Experiment with Milch Cows," page 59.

Statement of crops raised upon the north division of Field C: —

White soja bean (*Soja hispida*), four rows. The seed was raised upon the station grounds in 1890. It was sown in rows three feet and three inches apart, May 18; the young plants appeared above ground May 30, and began to bloom during the middle of July. The lower leaves began to dry up September 4. The crop was pulled to collect the seed September 25.

Black soja bean, four rows. This variety is of a lighter-green color, and seems to be somewhat more vigorous than the former. It is still green when the white variety has turned yellow. We have raised for several years, successfully, large crops of both varieties of soja bean, and consider them for our locality a most valuable addition to our forage crops.

Serradella (*Ornithopus sativus*), eight rows, three feet three inches apart. Sown May 14; began to bloom July 20; appeared somewhat affected by blight September 3, but recovered from this trouble towards the close of September, and was in a healthy condition by October 6. The crop was light, compared with results of previous years; it resisted cold spells to an exceptional degree, being still green October 23. The serradella has furnished us in previous years an exceptionally valuable green fodder, at the rate of from ten to eleven tons of green feed per acre.

Bokhara clover (*Melilotus alba*), four rows, three feet three inches apart. Sown May 23, and had reached a height of over three feet June 16, when it was cut, not yet in bloom. The second growth was much lighter than the first, and was blooming August 7. The plants were not affected by frost October 13. The Bokhara clover furnishes a luxuriant growth, and has a pleasant aromatic odor. It deserves a trial as ensilage, when cut before blooming.

Spring vetch (*Vicia sativa*), four rows, three feet three inches apart. The seed was sown May 14. The young plants appeared above ground May 23, and began to bloom July 2. The crop was cut when beginning to dry, August 17. This plant has a well-established reputation as an excellent fodder crop for dairy purposes. We have for several years raised, very satisfactorily, a mixed crop of vetch and oats, to serve as green fodder for our cows. The yield is liberal, and makes a good hay when properly dried.

Winter vetch, four rows. This variety proved to be somewhat later in blooming, otherwise it showed no particular difference from the former.

Kidney vetch, four rows, two feet apart. The seed was sown May 14; the young plants were noticed above ground May 23. The growth was very slow, the plants measuring only three inches in height September 19. They failed to develop blossoms.

Sainfoin (*Onobrychis sativa*), four rows, three feet three inches apart. Sown May 23, 1890; began blooming May 25. The growth was twenty inches high and almost through blooming when cut, July 17. The second crop was light. Frosts during October did not affect the foliage. Several years' trial shows that the growth is frequently seriously winter-killed.

Yellow trefoil, four rows, three feet three inches apart.

Sown May 14; was up May 27. The growth was very slow, being about four inches high September 19. The first blossoms appeared sparingly October 6. The plants withstood less successfully the October frosts, as compared with some of the previously described crops.

Yellow lupine (*Lupinus lutens*), four rows, three feet three inches apart. Sown May 15; came up May 25. The plants were ten inches high July 14; began blooming when sixteen inches high, July 20. They reached the height of two feet September 18, when an abundance of seed-pods were formed.

White lupine (*Lupinus alba*), four rows, three feet three inches apart. Sown May 15; came up May 23; began to bloom July 4, when twenty-eight inches high. The plants were thirty-eight inches high July 21, and still continued to grow. This crop when in its succulent state (July) has served in preceding years in a superior degree as efficient green manure for winter crops and exhausted grass lands.

Forest pea (*Lathyrus sylvestris*), four rows, two feet six inches apart. Sown May 15; the plants came up sparingly June 10. The growth was very slow, being only four inches high September 19. Frosts did not affect it as late as October 13. This plant is new as a forage crop in Germany and England. Our seed was imported from the latter place, and not the best kind. As it is a biennial plant, another year is needed to form an opinion regarding its economical value.

Common buckwheat (*Fagopyrum esculentum*), four rows, two feet apart. Sown May 14. It began to bloom June 20, and was cut for fodder when the seeds began to set, July 27.

Japanese buckwheat, four rows, two feet apart. Sown May 14; blossomed June 23, and was cut for fodder, like the former variety, July 27. The plants are somewhat more hardy than the common buckwheat.

Silver-hull buckwheat; four rows. Sown May 14; bloomed June 20, and showed a liberal formation of seed-pods July 27, when the crop was cut. A second lot, seeded down June 25, began to bloom July 21, and had finished blossoming August 26. In regard to the weight of the crop harvested, the buckwheats ranked in this order: silver-hull, Japanese, common variety.

Stachys tubers (*Stachys affinis*), little tubers sent on by the Department of Agriculture in Washington, were planted (one row) April 21. They came up May 1; had reached a growth of nine and one-half inches September 19, when suckers came out. Frost did not affect the foliage before October 28. The tubers were left in the ground for observations during the coming year. The tubers are considered a substitute for potatoes in the south of France.

Chinese potato bulblets, sent on for trial as a potato substitute by the United States Department of Agriculture. They were planted April 21, two feet apart in the row; came up May 30, and were from two to three inches high July 14. The plants send out runners from eighteen to twenty inches in length. Leaves suffered from frost October 1. The bulblets were left in the ground for observations during the coming year.

Prickly comfrey (*Symphytum officinale*), one row. The roots for planting were kindly presented by Col. J. D. W. French, and were put in the ground Oct. 11, 1890, two feet apart in the row. They produced a luxuriant growth during the late spring; began to blossom June 5, and reached a height of twenty inches, with numerous highly foliaceous branches. The blossoms were removed, to prevent a seeding out. The plants kept green until the middle of October.

English rye-grass (*Lolium perenne*), three rows. This variety of grass has been raised for a number of years on various fields of the station farm, to ascertain its degree of resistance to the influence of our winter climate. After repeated trials, it is safe to say that it is in an exceptional degree liable to winter-killing in our locality. One-half of the field was winter-killed during the previous winter.

Campbell's spring wheat, three rows, two feet apart. Sown May 4; appeared above ground May 22, and was ripe for cutting August 22. It made a rather light growth.

Winter wheat, twelve varieties, sent on from London, Eng. (Nos. 1–12 below). Each variety occupied five feet in the row, with one foot of space between them. They were sown Sept. 30, 1890. In connection with the English samples were sown two samples of winter wheat sent on by the United States Department of Agriculture (Nos. 13 and 14). Names of varieties: 1. Carter's Millers' Delight; 2. Carter's Stand Up; 3. Carter's Earliest of All; 4. Carter's Anglo-Canadian; 5. Carter's Pride of the Market; 6. Carter's Pearl; 7. Carter's Bird Proof; 8. Carter's Prince of Wales; 9. Carter's Queen; 10. Carter's Hundred Fold; 11. Carter's Flour Ball; 12. Carter's Holborn Wonder; 13. Hybride Dattel; 14. Hybride Larned. No. 4 was badly winter-killed; Nos. 8, 9, 10 and 11 suffered somewhat less from winter-killing; Nos. 1 and 2 were both in good condition. Most of the varieties began to blossom June 21. Nos. 1 and 3 matured first. They were cut July 21. Nos. 2, 5, 7, 8 and 14 were cut August 5, Nos. 6 and 11 were cut August 8, and Nos. 4 and 13 were cut August 12. Our last year's experience with winter wheat has been discouraging, on account of serious damage by frost in all parts of the field.

Kansas king corn, one row. Sown with seed sent on for trial May 20. It was above ground May 30, reached nine feet in height September 19, and was killed by frost October 13, without being matured.

Jerusalem corn, one row, on trial. Sown May 20; appeared above ground May 30; was five inches high July 14; blossomed September 19, when sixty-two inches high, and was killed by frost October 13, when still immature.

Sugar beets, five European varieties. The seeds were received from the United States Department of Agriculture for trial. Five rows of each variety were planted May 20. The young plants were above ground May 27; they were thinned out (from six to eight inches apart) June 22. The crop looked well until the beginning of September, when a brown fungous growth appeared on the leaves. The roots were harvested October 19. They yielded as follows: —

	Pounds.
Florimond Desprez's Richest,	710
Bulteau Desprez's Richest,	690
Dippe's Kleinwanzleben,	600
Dippe's Vilmorin,	620
Simon Le Grand's White Improved,	550

Analysis of Sugar Beet Roots, raised 1891.

VARIETY.	Date of Test.	Average Weight of Beets (Grams).	Moisture at 100° C.	Temperature of Juice.	Degrees, by Brix.	Sugar in Juice, by Fehling's Test (Per Cent.).
Florimond Desprez's Richest, . .	Dec. 3, .	508.06	85.87	18° C.	14.3	13.35
Bulteau Desprez's Richest, . . .	Dec. 2, .	498.10	84.54	17° C.	14.4	13.06
Dippe's Kleinwanzleben, . . .	Dec. 2, .	463.52	83.59	19° C.	15.2	13.88
Dippe's Vilmorin, ...	Dec. 1, .	522.00	83.75	19.5° C.	15.6	12.54
Simon Le Grand's White Improved,	Dec. 3, .	435.22	81.49	20° C.	16.8	15.67

2. *South Division, Garden Crops.*

This part of Field C, 328 feet long and 88 feet wide (28,864 square feet), was subdivided as above stated during the spring of 1891 into five plats of a uniform size and shape (88 feet by 62 feet, one-eighth of an acre), running from north to south across the main field. These were separated from each other by an unmanured space of from four to five feet in width. The soil was several feet deep, and consisted of a rather light loam in a good state of cultivation as far as its mechanical condition is concerned. No other manurial matter but fine-ground bone and muriate of potash, 600 pounds of the former and 200 pounds of the latter per acre, was used before 1891. The field slopes very gently from west to east. The plats were numbered 1, 2, 3, 4, 5, beginning on the east end of the field. Each plat received, spring of 1891, a manurial mixture of its own as fertilizer. The difference of the fertilizers applied consisted essentially in the circumstance that nitrogen and potash were used in several of them in different forms. All plats received practically the same quantity of nitrogen, potash and phosphoric acid, and every one of them received its phosphoric acid addition in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in the form of organic animal matter, dried blood; others received their nitrogen in the form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received their potash in the form of muriate of potash and others in the form of the highest grade of potassium sulphate (in our market 95 per cent. purity). The subsequent tabular statement shows the quantities of the manurial substances applied to different plats: —

Plat 1, . . .	75 pounds dried blood. 30 pounds muriate of potash. 40 pounds dissolved bone-black.
Plat 2, . . .	47 pounds nitrate of soda. 30 pounds muriate of potash. 40 pounds dissolved bone-black.
Plat 3, . . .	38 pounds sulphate of ammonia. 30 pounds muriate of potash. 40 pounds dissolved bone-black.
Plat 4, . . .	47 pounds nitrate of soda. 30 pounds high-grade sulphate of potash. 40 pounds dissolved bone-black.
Plat 5, . . .	38 pounds sulphate of ammonia. 30 pounds high-grade sulphate of potash. 40 pounds dissolved bone-black.

		Pounds.
Per acre:	Phosphoric acid, ...	50.4
	Nitrogen, ...	60.0
	Potassium oxide, ...	120.0

The different fertilizers were applied broadcast, and subsequently slightly ploughed under in all cases on the same day (April 22, 1891). All plats were planted in the same order with the same kind of garden crops (eight). Every plat was either planted with young plants or was sown with the seed, as circumstances dictated, each kind on the same day and in the same manner. The young plants used for the experiment were raised under corresponding conditions from seed in the hot-bed. The seeds used were in several cases sent on for trial. The different kinds of garden crops were arranged in the following order, beginning on the east side of each plat: —

Lettuce, White Tennis Ball, one row.
Spinach, Long Standing and Bloomingdale, one row each.
Beets, Egyptian and Dewings, one row each, or two of a kind.
Celery, White Plume, one row.
Kohlrabi, two rows.
Cabbage, Red Dutch and several white varieties, three rows in all.
Tomatoes, Boston Market, two rows.
Potatoes, Beauty of Hebron, five rows.

Spinach, beets and potatoes were raised from seeds upon the different plats. Lettuce, celery, kohlrabi, cabbage and tomatoes were sown in a hot-bed and subsequently transferred when of suitable size, each kind for all plats on the same day, as will be found farther on. All crops were kept clean during the growing season by a timely use of the cultivator and the hoe.

Lettuce, White Tennis Ball, set out May 1. The growth was in the beginning slow, on account of cold and dry weather, but subsequently recovered rapidly and produced a good yield, judging from the general appearance of the crop. Plats 4 and 5 produced the best results, Plat 2 came next and plats 1 and 3 last.

Spinach, sown May 1. Bloomingdale grew more rapidly than Long Standing. Plats 4 and 5 gave best results, Plat 2 next and plats 1 and 3 last.

Beets, Dewings and Egyptian, each one row, sown May 21. The young plants appeared above ground June 1; they were thinned out July 11 and harvested October 17, with the following results, Plat 4 leading: —

PLATS.	Dewings.	Egyptian.	Total.
	Pounds.	Pounds.	Pounds.
Plat 1, ...	225	140	365
Plat 2, ...	240	155	395
Plat 3, ...	240	180	420
Plat 4, ...	245	240	485
Plat 5, ...	220	190	410

Celery, White Plume, one row, set out June 1. The plants were banked August 20; they were taken out October 28. Plats 4 and 5 showed best and plats 2 and 3 worst.

Kohlrabi, two rows, planted with young plants from the hot-bed May 18; they were harvested July 16, with the following results: —

	Pounds.
Plat 1,	105
Plat 2,	120
Plat 3,	115
Plat 4,	145
Plat 5,	152

Cabbage, Red Dutch in all plats, varieties of other kinds only here and there in different plats. Judging from the general appearance of the crop, it seemed that plats 1, 2 and 3 were leading. On the whole the yield was quite satisfactory. No weights were taken, on account of the different varieties in the plats.

Tomatoes, Boston Market, two rows, set out May 30. Plats 2 and 3 showed the poorest development of the plants; they had the first few ripened tomatoes August 5. The following weights of ripe and healthy tomatoes were collected from different plats during the season: —

DATE.	PLATS.				
	1	2	3	4	5
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
August 25,	67.0	44.0	92.5	124.0	118.0
August 31,	65.0	11.5	63.0	211.0	257.0
September 8,	67.0	30.5	95.0	211.0	168.0
September 17,	99.5	65.0	84.0	101.5	98.0
Total,	298.5	150.0	334.5	647.5	641.0

Potatoes, Beauty of Hebron, five rows, were planted in each plat May 1. The rows were three feet three inches apart and the hills two feet apart in the row. The young plants appeared above ground quite uniformly May 21.

The vines in all plats looked healthy throughout the season; they began to turn yellow first on Plat 2. The potatoes on all plats were harvested August 11 and 12, when the leaves were dead but the stems still green. They were smooth and free from scab. The different plats yielded the following weights of large, marketable potatoes and of small potatoes: —

PLATS.	Large Potatoes.	Small Potatoes.	Total.
	Pounds.	Pounds.	Pounds.
Plat 1, ...	540	130	670
Plat 2, ...	550	110	660
Plat 3, ...	660	90	750
Plat 4, ...	670	110	780
Plat 5, ...	620	115	735
	3,040	555	3,595

This experiment will be continued during the coming season with the same crops and with the same mixtures of fertilizing ingredients, making such alterations as the experience of the past season suggests. The results of the first year are above presented without any further comment.

A critical discussion of the results is deferred to a later period in our investigation, when the experience of several years will furnish a safer basis for deduction.

4. Experiments with Stowell's Evergreen Sweet Corn for Ensilage (1891).

Field D.

The area occupied by this field is 328 feet long and 70 feet wide (22,960 square feet, or .53 of an acre). It runs parallel with Field C from east to west, and is separated from the latter by an unmanured strip of grass land 20 feet wide. The land has served in previous years for various field and garden crops, and was manured annually for several years back with 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The soil consists of a light loam, is fairly uniform and several feet in depth. It was ploughed during the autumn of 1890 and reploughed April 17, 1891. The same amount of fine-ground bone and muriate of potash as in preceding years was applied broadcast April 24 (315 pounds of the former and 105 pounds of the latter).

The entire field was planted May 2 with Stowell's Evergreen sweet corn; the seed did not come up very satisfactorily.

New seed corn was planted May 25 with good success; yet the crop remained late throughout the season. The crop with ears well developed, kernels in the milk, was cut for ensilage September 10. The total yield amounted to 17,800 pounds, or 16.9 tons per acre.

The whole plant was cut into pieces of from one to two inches in length, and without delay carefully packed into a silo in a way similar to that described in previous reports. The ensilage is designed to serve during the present winter season in feeding experiments, to compare its merits with ensilage prepared from a dent corn variety, Pride of the North, raised under similar conditions and of a corresponding state of maturity.

Field E.

This field was divided during the past year into two parts. The larger part was manured and planted in the same manner as Field D, with Stowell's Evergreen. The remainder was sown with several species of medicinal plants sent on for trial by the United States Department of Agriculture. The corn proved a success, and after being fully matured was cut. The ripe air-dry ears were subsequently collected; they weighed 729 pounds. The air-dry stover (2,520 pounds) served for a comparative feeding experiment with milch cows.

The majority of the seeds of the medicinal plants proved a failure. Opium poppy (*P. somnifera*), Russian rhubarb (*Rheum officinale*) and castor bean (*Ricinus communis*) did well.

Fodder Corn (Stowell's Evergreen), Station, Field D.
(Cut Sept. 10, 1891.)

	Per Cent.
Moisture at 100° C.,	83.91
Dry matter,	16.09
	100.00

Analysis of Dry Matter.

Crude ash,	6.73
" cellulose,	26.03
" fat,	3.26
" protein (nitrogenous matter),	8.09
Non-nitrogenous extract matter,	55.89
	100.00

5. EXPERIMENTS TO STUDY THE ECONOMY OF USING DIFFERENT COMMERCIAL SOURCES OF PHOSPHORIC ACID FOR MANURIAL PURPOSES IN FARM PRACTICE.

Field F.

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under, and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella), followed each other in the order stated.

1890. — The land had been ploughed during the preceding fall, and again April 19, 1890. The field was subdivided subsequently into five plats of definite size, each running from east to west. These plats were separated from each other by a space eight feet wide.

The plats and spaces between them were ploughed and harrowed alike. The plats were fertilized at stated times; the spaces which separated them received at no time any kind of manurial matter.

The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article; namely, phosphatic slag, Mona guano, apatite, South Carolina phosphate (floats), and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value, in its particular kind of phosphate.

	Cost per Ton.
Phosphatic slag,	$15 00
Mona guano (West Indies),	15 00
Ground apatite (Canada),	6 25
South Carolina phosphate (floats),	15 00
Dissolved bone-black,	25 00

Analyses of Phosphates used.

[I. Phosphatic slag; II. Mona guano; III. Apatite; IV. South Carolina phosphate (floats); V. Dissolved bone-black.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	0.47	12.52	0.09	0.39	15.96
Ash,	–	75.99	–	–	61.46
Calcium oxide,	46.47	37.49	–	46.76	–
Magnesium oxide,	5.05	–	–	–	–
Ferric and aluminic oxides,	14.35	–	–	5.78	–
Total phosphoric acid,	19.04	21.88	36.08	27.57	15.82
Soluble phosphoric acid,	–	0.00	–	0.00	12.65
Reverted phosphoric acid,	–	7.55	–	4.27	2.52
Insoluble phosphoric acid,	–	14.33	–	23.30	0.65
Insoluble matter,	4.39	2.45	9.55	9.04	6.26

The following fertilizers were applied to the different plats April 17, 1890: —

Plat I. (south side), 6,494 square feet,	127 pounds of ground phosphatic slag. 43 pounds of nitrate of soda. 58 pounds of potash-magnesia sulphate.
Plat II., 6,565 square feet,	128 pounds of ground Mona guano. 43½ pounds of nitrate of soda. 59 pounds of potash-magnesia sulphate.

Plat III., 6,636 square feet, .	304 pounds of ground apatite.
	44 pounds of nitrate of soda.
	59 pounds of potash-magnesia sulphate.
Plat IV., 6,707 square feet, .	131 pounds of South Carolina phosphate.
	44½ pounds of nitrate of soda.
	60 pounds of potash-magnesia sulphate.
Plat V., 6,778 square feet, .	78 pounds of dissolved bone-black.
	45 pounds of nitrate of soda.
	61 pounds of potash-magnesia sulphate.

The phosphatic slag, Mona guano and South Carolina floats were applied at the rate of 850 pounds per acre, apatite at the rate of 2,000 pounds per acre; dissolved bone-black at the rate of 500 pounds per acre. These figures represent approximately the equal local cash values of the different sources of phosphoric acid applied. Nitrate of soda corresponds in all cases to an application of 290 pounds per acre, and the potash-magnesia sulphate to that of 390 pounds per acre.

The field was planted with potatoes, Beauty of Hebron; the large-sized ones were cut in halves, and the small ones left whole, when planted, May 1, 1890. The rows were three feet three inches apart, and the hills in the rows eighteen inches. Each plat had sixteen rows. The young plants came up quite uniformly; they were cultivated and hoed June 2. Several applications of Paris green with plaster were made during the season, to prevent damage by potato bugs. The crop looked well until the middle of July, when the effects of a serious drought showed itself to such an extent that the maturing seemed to be hastened on by it.

The potatoes were harvested from all the plats August 12 to 14. They were assorted in the field into marketable ones and small ones. The former were sold at sixty cents per bushel; the latter were used for chicken feed, at twenty cents per bushel, — our local market prices.

No. of Plat.	Total Yield of Potatoes (Pounds).	Marketable Potatoes (Pounds)	Small Potatoes (Pounds)
I. (south end),	1,600	1,215	385
II.,	1,415	915	500
III.,	1,500	1,070	430
IV.,	1,830	1,380	450
V. (west end),	2,120	1,590	530

Yield per Acre.

I. Phosphatic slag,	10,671	8,087	2,584
II. Mona guano,	9,388	6,071	3,317
III. Ground apatite,	9,845	7,023	2,822
IV. South Carolina phosphate,	11,886	8,963	2,923
V. Dissolved bone-black,	13,626	10,218	3,408

Statement of Percentages.

Plats.	Marketable Potatoes (Per Cent).	Small Potatoes (Per Cent).
I.,	75.78	24.22
II.,	64.66	35.34
III.,	71.32	28.68
IV.,	75.40	24.60
V.,	74.91	25.09

Money Value of Crop.

[One bushel = 60 pounds.]

Plat.	Marketable Potatoes, at 60 Cents per Bushel.	Small Potatoes, at 20 Cents per Bushel.	Total Sum.
I.,	134.6 bushels = $80 76	43.0 bushels = $8 60	$89 36
II.,	101.2 bushels = 60 72	55.3 bushels = 11 06	71 78
III.,	117.1 bushels = 70 26	47.1 bushels = 9 42	79 68
IV.,	149.3 bushels = 89 58	48.7 bushels = 9 74	99 32
V.,	170.3 bushels = 102 18	56.8 bushels = 11 36	113 54

As a first year's results, the above statements were published without any further comment beyond the remark that the exceptional dryness of the season might have favored a superior action of the soluble phosphoric acid as compared with the insoluble one. Attention was also called to the important circumstance that an accumulation of phosphoric acid in the soil might eventually affect the results as time advances. The largest yield of potatoes had only removed 3.4 pounds of phosphoric acid from the soil.

Plat I. received 24.18 pounds of phosphoric acid.
Plat II. received 28.01 pounds of phosphoric acid.
Plat III. received 109.68 pounds of phosphoric acid.
Plat IV. received 36.12 pounds of phosphoric acid.
Plat V. received 12.34 pounds of phosphoric acid.

Tabular Statement of the Approximate Amount of Nitrogen, Phosphoric Acid and Potash in the Crop raised.

PLATS.	Pounds of Potatoes per Plat.	Pounds of Nitrogen in Tubers.	Pounds of Phosphoric Acid in Tubers.	Pounds of Potassium Oxide in Tubers.
I., ...	1,600	5.440	2.560	9.280
II., ...	1,415	4.811	2.364	8.207
III., ...	1,500	5.100	2.400	8.700
IV., ...	1,830	6.222	2.928	10.614
V., ...	2,120	7.208	3.392	12.296

The calculation is based on E. Wolff's average analyses, 1,000 pounds of potatoes containing: nitrogen, 3.4 pounds; phosphoric acid, 1.6 pounds; and potassium oxide, 5.8 pounds.

1891. — The experiment was continued by selecting winter wheat as the next crop to be raised. For this purpose the soil was ploughed soon after the potatoes had been harvested, and subsequently manured and harrowed, as in case of the preceding crop. The change in the mode of manuring the different plats was confined to Plat III., which received no ground apatite, for the reason that none could be obtained from the party that furnished our first supply of this article. No other form of phosphoric acid was substituted.

The following table shows the kind and amount of fertilizers applied to the plats : —

Plat I. (south side), 6,494 square feet, . . .	127 pounds of ground phosphatic slag. 43 pounds of nitrate of soda 58 pounds of potash-magnesia sulphate.
Plat II, 6,565 square feet, .	128 pounds of ground Mona guano. 43½ pounds of nitrate of soda. 59 pounds of potash-magnesia sulphate.
Plat III., 6,636 square feet, .	44 pounds of nitrate of soda. 59 pounds of potash-magnesia sulphate.
Plat IV., 6,707 square feet, .	131 pounds of South Carolina phosphate. 44½ pounds of nitrate of soda. 60 pounds of potash-magnesia sulphate.
Plat V., 6,778 square feet, .	78 pounds of dissolved bone-black. 45 pounds of nitrate of soda. 61 pounds of potash-magnesia sulphate.

The wheat — two new French varieties of winter wheat, Hybrid Dattel and Hybrid Larned, sent on for trial by the United States Department of Agriculture — was sown Sept. 26, 1890. The young plants came up well, but were found winter-killed in the succeeding spring. The entire field was reploughed and seeded down with summer wheat in rows two feet apart May 11, 1891. The seed proved good and the crop did well during the entire season. A marked difference in the general character of the growth upon different plats could be noticed as the season advanced. Plats I. and V. were leading throughout the season, while Plat III. was least promising and matured last.

Following is a statement showing the height of the crop on the different plats at different periods of the season : —

PLATS.	June 16 (Inches).	June 23 (Inches).	June 30 (Inches).	July 7 (Inches).	July 14 (Inches).	July 21 (Inches).	Aug. 11 (Inches).
Plat I, . .	12	20	29	31	46	48	48
Plat II., . .	11	18	25	29	40	42	42
Plat III., .	7	11	17	22	28	34	34
Plat IV., .	12	18	25	29	41	45	45
Plat V., . .	12	20	27	31	47	48	48

The crop upon plats I., II., IV. and V. was cut August 14, and that on Plat III. August 18. The entire yield was moved into the barn August 20, where it remained stored until September 25, when the product of each plat was weighed and threshed, with the following results: —

PLATS.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.
Plat I, . . .	380	67	313	17.63	82.37
Plat II., . . .	340	73	267	21.47	78.53
Plat III., . . .	215	38	177	17.67	82.33
Plat IV., . . .	380	78	302	20.53	79.47
Plat V., . . .	405	59	346	14.57	85.43
	1,720	315	1,405		

An examination of the above tables shows that the total yield of wheat was highest upon Plat V., and lowest upon Plat III. The larger yield of Plat V. (dissolved bone-black) is in an exceptional degree due to the large production of straw and chaff, as compared with that of the grain. Plats II. (Mona guano) and IV. (South Carolina phosphate) yield the largest percentage of grain.

6. EXPERIMENTS WITH A WESTERN VARIETY OF DENT CORN, PRIDE OF THE NORTH, FOR ENSILAGE.

Field G.

This field is a part of a former meadow. Grass has been raised here for more than fifteen years in succession. A moderate top-dressing of barn-yard manure has kept the land in a fair condition for the production of hay. Eight years ago a row of drain pipes four inches in diameter was laid along its whole length. Branch drains pass into it in several places, to prevent the accumulation of water from surrounding localities. The land is nearly a level, and the soil a loam several feet in depth, here and there underlaid with a hardened clay. The area is 700 feet long and 75 feet wide, running from north to south to the east of Field A. During the fall of 1890 the sod was turned under and left over winter to disintegrate. During the late spring the soil was again ploughed and the remaining sod cut up with a wheel harrow. After subsequent harrowing it was planted May 13 with a dent corn variety, Pride of the North, in rows three feet three inches apart, the hills being two feet apart in the row. No manure was applied on that occasion, the object being to reduce the stored-up plant food, and thereby prepare the soil for future field experiments with special fertilizers.

The young plants came up well and made a handsome growth. At the time when the kernels began to glaze ten and two-thirds tons were cut to be converted into ensilage September 10. The remainder of the crop was cut September 16, to secure matured ears and corn stover. The air-dried stover thus obtained weighed, October 19, 4,185 pounds, and the ears 2,500 pounds.

The area used for ensilage corn, 25,650 square feet, yielded at the rate of eighteen tons and three hundred pounds per acre. The area turned to account for ears and stover, 26,850 square feet, produced at the rate of 4,056 pounds of ears and 6,782 pounds of stover per acre.

Fodder Corn (Pride of the North), Station, Field G.
(Cut Sept. 10, 1891.)

	Per Cent.
Moisture at 100° C.,	71.86
Dry matter,	28.14
	100.00

Analysis of Dry Matter.

Crude ash,	3.78
" cellulose,	25.67
" fat,	2.24
" protein (nitrogenous matter),	7.62
Non-nitrogenous extract matter,	60.69
	100.00

7. EXPERIMENTS WITH GRASS LAND (MEADOWS).

The permanent grass lands are by their location arranged into two divisions, west and east of a public highway. They cover at present a space of sixteen to seventeen acres.

The *west side division* consists of old meadows, kept for over twenty years in grass. The area has for years been steadily reduced in size by turning, as circumstances advised, more or less at a time into plats for field experiments. In their present condition they surround our main field for experimental purposes. They are in part underdrained, and are kept, by a moderate annual top-dressing with barnyard manure, in a fair state of production, considering the condition of the sod. The area comprises to-day approximately not more than seven acres. Thirteen tons of hay, first cut, and two and three-quarters tons of rowen, hay of second cut, was the yield in 1891.

The *east side division* of meadows comprises an area of about 9.6 acres. The entire field to 1886 consisted of old, worn-out grass lands, overrun with a worthless growth on its more elevated portion, and covered with weeds and sedges in its lower section. The improvement of the land by underdraining and ploughing, and subsequently by the use of a system of drill culture, began in some parts (north end) in 1886, and in others (south end) in 1887. For the details of this work, as well as of the subsequent seeding down into permanent grass land, I have to refer to preceding annual reports.

It will suffice, for the appreciation of the present yield of these new meadows, to call attention once more to the following circumstances.

1886. — As soon as the drain tiles were covered and the ditches as far as practicable levelled, the entire area was ploughed, and the main depressions filled up with stones and earth, or earth, as circumstances advised, and left in that condition over winter.

1887. — The succeeding spring a wheel harrow was used to break up the rotten sod. The soil was subsequently repeatedly ploughed and harrowed, until it showed the desirable mechanical condition required for a successful cultivation of summer grain crops.

Barley and oats were chosen as the first crops in case of the meadow north of the new roadway. Both were seeded in drills, with rows two feet apart, to permit a thorough destruction of an objectionable foul growth by a frequent use of the cultivator and hoe.

As soon as these crops were harvested, one ton of wood ashes per acre was ploughed in, to assist in the disintegration of the excess of organic peaty matter, and to serve as a general fertilizer. Ploughing once more and smoothing the surface by means of a brush harrow, the entire area was seeded down into grass to serve as meadow. The latter was subsequently cut into two, by a road built for communication to more remote fields. This arrangement caused a division into a northern and southern meadow.

1888. — In case of the land south of the roadway, leguminous plants, as soja bean, Southern cow-pea and serradella, served as first crop. The system of drainage and of seeding down remained the same as before. The meadow north of the road covers an area of somewhat more than six acres, and that south of the road is about three acres in size. The meadow north of the road was sown for the first time in the fall of 1887, with grass, and the one south of the roadway in the fall of 1888.

The more elevated portions of both were seeded down with the following mixture of grass seeds, at the rate of from two to two and one-half bushels per acre : —

Two bushels herds grass (*Phleum pratense*).
Two bushels red top (*Agrostis vulgaris*).
Two bushels Kentucky blue-grass (*Poa pratensis*).
Two bushels meadow fescue (*Festuca pratensis*).
Seven pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

Early in the succeeding spring a mixture of equal weights of medium red clover and alsike clover was added broadcast, at the rate of from five to six pounds per acre.

The lower and still more wet portion of the meadow was seeded down with the following mixture of grass seeds : —

Twenty pounds of soft brome grass (*Bromus mollis*).
Twelve pounds herds grass (*Phleum pratense*).
Nine pounds red fescue (*Festuca rubra*).
Eight pounds fowl meadow grass (*Poa serotina*).
Seven pounds Rhode Island bent (*Agrostis alba*).
Six pounds orchard grass (*Dactylis glomerata*).
Five pounds crested dog-tail (*Cynosurus cristatus*).
Four pounds meadow soft grass (*Holcus lanatus*).
Two pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

1889. — From four to five pounds of alsike clover per acre were added by broadcast seeding early in the succeeding spring (1889).

The seed came up well, and suffered but here and there in wet spots during the first winter. Barren spots were reseeded.

Both meadows were cut but once during the first summer season, somewhat later than usual; the majority of grasses did not, as might be expected, head out.

As soon as the first crop of hay was secured, a system of manuring was planned, which would illustrate the comparative manurial effect of top-dressing, as follows: —

By barn-yard manure.
By ground bones and muriate of potash.
By unleached wood ashes.

The northern meadow, consisting of six and one-half acres, was subdivided into three plats, I., II., III., running from east to west, leaving a space of twenty feet in width between them without any manurial matter.

The southern meadow was divided into two plats, IV., V. (south end). Plats I., II., III. were sown down in grass during September, 1887, and plats IV. and V. during September, 1888. The subsequent stated system of manuring began in the autumn of 1888, on all plats at the same time.

Plat I. (north end of the field) is equal to 1.92 acres. It was top-dressed during the fall and early spring with barn-yard manure, at the rate of eighteen tons per acre (1888–89).

Plat II. covers a similar area to Plat I. (83,640 square feet). It received at the same time a top-dressing of barn-yard manure, at the rate of eight tons per acre (1888).

The coarsest part of the barn-yard manure was subsequently removed from both plats before the growing grass interfered with its being raked off.

Plat III., about 2.41 acres, received, May 3, 1889, a top-dressing of six hundred pounds of fine-ground steamed bone and two hundred pounds of muriate of potash per acre.

Plat IV. (south of roadway), an area of 2.11 acres, received the same dressing, in the same proportion and at the same rate (six hundred pounds ground bone and two hundred pounds muriate of potash) per acre as Plat III. (1889).

Plat V., equal to .91 acres, received, as top-dressing, April 23, 1889, one ton of unleached Canada wood ashes, from our local market (1889).

Yield of Hay in Case of Plats I., II. and III. (Second Year after Seeding), and of Plats IV. and V. (First Year after Seeding).

PLAT I.	First Cut.	Second Cut.
1.92 acres, . .	10,500 pounds, June 24.	4,370 pounds, August 26.
Total yield per acre, 7,745 pounds, or 3.87 tons.		

PLAT II.	First Cut.	Second Cut.
1.92 acres, . .	9,130 pounds, June 24.	4,650 pounds, August 26.
Total yield per acre, 7,177 pounds, or 3.59 tons.		

PLAT III.	First Cut.	Second Cut.
2.41 acres, . .	12,200 pounds, June 24.	4,950 pounds, August 26.
Total yield per acre, 7,116 pounds, or 3.56 tons.		

Plat IV. (2.11 acres); Plat V. (.91 acres): The first year's hay consisted nearly entirely of herds grass, which was almost the only variety which had headed out in June. The yields of both plats were harvested together.

First Cut.	Second Cut.	Total Yield per Acre.
8,130 pounds, June 24.	3,105 pounds, August 31.	3,720 pounds, or 1.86 tons.

1890. — The different plats were prepared in a similar manner for the season of 1890 as they had been for the preceding season, 1889.

Plats I. and II. received a top-dressing of barn-yard manure during the months of October and November; the former at the rate of fourteen tons per acre, and the latter at the rate of eleven tons.

Plat III. was treated in April, 1890, as before, with a mixture of six hundred pounds of fine-ground bones and two hundred pounds of muriate of potash.

Plats IV. and V. were merged into one plat, and received a top-dressing of unleached wood ashes, at the rate of one ton per acre, April 19, 1890.

Barren spots in this plat, it being the second year after seeding down, were reseeded by the same seed mixture which had been used before.

The entire meadow received an addition of from two to three pounds of alsike clover seed, broadcast, per acre.

All plats were cut as far as practicable at the same time.

Yield of Hay in 1890.

PLAT I.	First Cut.	Second Cut.
1.92 acres, . .	14,625 pounds, July 1.	3,790 pounds, Sept. 1.
Total yield of hay, 18,415 pounds. Yield per acre, 9,591 pounds, or 4.80 tons.		

Yield of Hay in 1890 — Concluded.

PLAT II.	First Cut.	Second Cut.
1.92 acres, . .	12,480 pounds, July 1.	3,105 pounds, Sept 3.

Total yield of hay, 15,585 pounds.
Yield per acre, 8,117 pounds, or 4.06 tons.

PLAT III.	First Cut.	Second Cut.
2.41 acres, . .	14,460 pounds, June 26.	3,535 pounds, September.

Total yield of hay, 17,995 pounds.
Yield per acre, 7,466 pounds, or 3.73 tons.

PLAT IV. (IV. and V., **1889.**)	First Cut.	Second Cut.
3 acres, . . .	13,380 pounds, July 1.	4,080 pounds, Sept 3.

Total yield of hay, 17,460 pounds.
Yield per acre, 5,820 pounds, or 2.91 tons.

The total yield of hay on plats I., II. and III. averages 4.19 tons per acre. The total yield on Plat IV. averages 2.91 tons per acre.

The weight of the second cut of hay (rowen) averages about one-fourth of that of the first cut. The dryness of the season during the latter part of July affected seriously the yield of the second cut. The wet season of 1889, as compared with the dry season of 1890, as well as the difference in the age of the two meadows, renders further comparison not advisable at this early stage of our investigation.

1891. — The same system of manuring the different plats was adopted as in the preceding years; some reduction, however, was made, with reference to the quantity of barn-yard manure applied per acre to plats I. and II., to ascertain the limit of its usefulness. Plat I. was top-dressed with barn-yard manure at the rate of 8 tons and Plat II. at the rate of 6 tons per acre. Plat III. received, as in previous years, as top-dressing 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The barn-yard manure was applied during the autumn and winter; the bone and potash early in the spring. Plat IV. received, as before, a top-dressing of wood ashes at the rate of 1 ton per acre early during the spring.

All plats were cut as far as practicable at the same time, with the following results: —

Yield of Hay for the Year 1891.

PLATS.	First Cut.	Second Cut.
	Pounds.	Pounds.
Plat I, per acre,	6,528	1,446
Plat II, per acre,	5,988	1,440
Plat III, per acre,	4,641	1,015
Plat IV., per acre.	3,750	1,610

The dry season has evidently seriously reduced the yield, as compared with the preceding year.

8. REPORT ON GENERAL FARM WORK (1891).

Aside from the farm work connected with the different field experiments previously described, much has been accomplished in other directions.

Considerable progress has been made in perfecting the arrangement for a system of co-operative work in the vegetation house and upon the experimental plats in the field.

The new orchard for testing the influence of different systems of fertilization on the health and general condition of fruit trees has received the needed attention. More young trees have been planted, and suitable crops have been raised over the entire area to economize the ground while the trees are still small.

Some reputed fodder crops comparatively new to our locality have been raised on a sufficiently large scale to serve for feeding experiments. Most prominent among them are a mixed crop of spring vetch and oats, and soja bean, both for green fodder.

Several acres have been planted with oats, barley and Indian corn, besides some varieties of roots and potatoes to furnish fodder for our farm live-stock.

Two silos are filled, one with Stowell's Evergreen sweet corn and the other with a dent corn, Pride of the North, to compare their feeding value as well as their general economical merits under fairly corresponding conditions.

A new barn has been built, to allow a proper separation of the crops obtained in connection with different field experiments.

A liberal production of fodder crops for the support of the farm live-stock has been for economical reasons a leading object in the management of the farm.

The improvement of the general condition of the various parts of the farm, wherever circumstances admitted a free choice of means, has received at all times deserved attention.

The following statement is an enumeration of the principal crops raised on different parts of the farm, on lands either permanently assigned for the production of fodder for the live stock of the station or undergoing a course of preparation for future experiments.

	Tons.
Hay (first cut),	$38\frac{1}{2}$
Rowen (second cut),	$10\frac{1}{2}$
Fodder corn (green),	22
Corn stover (dry),	4
Roots (sugar beets, $2\frac{1}{2}$; carrots, $1\frac{1}{2}$; mangolds, 3 tons),	7
Rye (1,303 pounds grain, 3,572 pounds straw),	$2\frac{1}{4}$
Barley (1,838 pounds grain, 3,647 pounds straw),	$2\frac{1}{4}$
Oats (2,094 pounds grain, 5,532 pounds straw),	$3\frac{3}{4}$
Wheat (315 pounds grain, 1,405 pounds straw),	$\frac{4}{5}$
Potatoes,	$1\frac{4}{5}$
Vetch and oats (green),	$5\frac{1}{3}$
Soja bean (green),	$4\frac{1}{3}$
Miscellaneous crops,	2

9. Department of Vegetable Physiology.

Report by Prof. Jas. Ellis Humphrey.

During the past year the work of this department has gone on steadily, and with some interesting results. According to the plan indicated in our last report, the chief subjects of investigation during the winter and spring have been certain diseases of winter crops under glass. It is proposed to continue this line of work in the study of other such diseases, both because the equipment of the station affords facilities for such work, and because the extent of the green-house interest in Massachusetts renders such investigations appropriate and desirable. The writer will be glad to communicate with any person who suffers from any disease of plants grown under glass, and to receive diseased plants for study, as well as to render any service in his power to losers by open-air diseases in summer.

A very decided gain has been observable during the year in the importance and amount of the correspondence of the department and in the promptness and fulness with which inquiries addressed to persons who could furnish practical information to the department have been answered. This is gratifying, because it indicates that the efforts of the station to advance knowledge and disseminate information in the field of vegetable pathology, as well as in other lines in which its work has been longer established, are coming to be appreciated. As in the past, all correspondence will receive prompt attention.

The details of the year's work here reported are grouped under the following heads: —

1. The Rotting of Lettuce.
2. The Powdery Mildew of the Cucumber.
3. Various Diseases.
4. Preventive Treatment.
    a. In Genearl.
    b. For Smuts.

As heretofore, reference to the "General Account of the Fungi," in the seventh report of this station, will be found helpful to an understanding of these discussions.

THE ROTTING OF LETTUCE. — *Botrytis vulgaris* Fr.*

Gardeners who cultivate lettuce as a winter crop usually suffer somewhat and often lose extensively by the rotting of the plant while still only partially grown. The trouble ordinarily appears first upon the stem of the plant, about at the surface of the soil. Here may be seen at first a soft, dark, decayed spot, which rapidly spreads, penetrating the stem and involving next the bases of the lower leaves. The latter, being thus cut off from the plant by the decay of their bases, usually dry up. With the further progress of the decay, the centre of the head, with the tender inner leaves, becomes attacked, and soon collapses into a fetid, slimy mass. In the decaying tissues one can often recognize fungus threads; and, if they are left undisturbed, there appear on the decayed remains the fruiting threads and spores of a fungus, always the same. When portions of the attacked tissues are removed and placed in a moist chamber after being thoroughly washed, I have found that the same fungus develops promptly and abundantly, and is never accompanied by any other. The study of specimens from various sources has led always to the same result.

Infection experiments with the fungus on healthy plants have been attended with little success; but the most that can be said is that their results indicate that the fungus requires for its attack conditions not yet determined. They do not negative the very strong evidence furnished by the constant association of the fungus with the decay. These experiments have not been carried so far as is desirable, on account of a lack of sufficient suitable material, and further cultures which I hope to make this winter may show that we have here a case similar to that described by DeBary,† in which the fungus threads require to be nourished saprophytically for a time before they can gain sufficient vigor to enable them to attack and live parasitically upon their host.

The fungus in question is one of the imperfect forms known as *Botrytis* or *Polyactis*, and agrees in many respects with that described by Marshall Ward* as causing a disease of garden lilies. It appears to be able to live saprophytically upon decaying vegetable substances, and is often found upon them; but I have never been able to detect any traces of decay in lettuce in a house where the fungus was not abundantly to be found. These facts point to the conclusion that this *Botrytis* is the *cause* of the rotting, and not merely an accompaniment of decay due to some other cause. It seems doubtful, however, if the affection can be called a disease in the sense that the fungus is able to attack perfectly sound, healthy lettuce under ordinary conditions. I have never seen the decay begin elsewhere than at the lower part of the stem; and it is possible that some injury or imperfection at that place is necessary to furnish a point of attack.

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* Two plates which had been prepared to illustrate the first two articles of this report, and delivered to the lithographer, were unaccountably lost in the mail before their engraving had been completed. It was impossible to duplicate the drawings in season for this report, but they will be prepared and published as soon as practicable.

† Botan. Zeitung, 1886, Nos. 22–27.

The structure of the fungus is very simple. From the creeping vegetative threads arise the erect spore-bearing ones, which branch sparingly toward their tips. The ends of the branches become slightly swollen, and from each is developed a number of short, peg-like projections. Each of these now begins to swell at its tip into a globular body, which increases in size and finally becomes elliptical in form. This is the spore, which, when ripe, falls from its attachment. The spores germinate promptly in water or a nutrient solution, by pushing out one or more threads each. These threads, when supplied with nourishment, grow rapidly into a much-branched mycelium. In a few days the erect spore-bearing threads begin again to be formed, as above described. Well-nourished specimens growing in a moist atmosphere may, after the first spore cluster has been formed, put out a new branch from the fertile thread, just below the cluster of spores. This thread then grows to a considerable length and then develops at its tip a new spore cluster; and this process may be several times repeated. The result of such a course of development is to produce what appear to be very long, fertile threads, with spore clusters scattered at intervals along them.

Instead of a spore cluster, a thread may produce, apparently only when it comes in contact with some solid substance, a compact cellular mass, which clings closely to the surface with which it is in contact. These "organs of attachment" have been observed by several students of these fungi, but their real significance is not yet understood. The compact mass is formed by the interweaving and growing together of numerous short branches of the filament on which they are formed. I have noticed, also, that an abundant development of these organs is usually associated with the formation of few conidia, and *vice versa.* But the conditions which determine the preponderance of one or the other are very uncertain; for, in case of two parallel cultures prepared in the same way and carried on under apparently identical conditions, one produced abundant conidia and few attachment organs, while in the other the former were few and the latter were very numerous.

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* Annals of Botany, Vol. II., p. 319.

The history and structure of this fungus, as above described, would lead to the expectation that there will be found among the remains of the decayed plants the small, black masses of compacted threads known as *sclerotia*, which constitute the resting states of related fungi, and from which, finally, the perfect fructification is developed under favoring conditions. Careful examination of a quantity of material has failed to show any of these bodies; but it is by no means certain that they may not be formed, at least in some cases.

In its development, so far as observed, and in the details of its structure, this fungus appears to agree with the form known as *Botrytis* (*Polyactis*) *vulgaris* Fr., and is with little doubt the conidial stage of some sclerotium-producing *Peziza* (*Sclerotinia*).

From what has been said, it is evident that the thorough and careful culture and vigilant supervision of the plants are essential to the control of the disease in question. The nature of the crop forbids the trial of fungicides, and chief attention must be devoted to the healthy growth of the plants. The soil should be rich and mellow enough to insure a rapid and vigorous growth. The temperature of the houses should not be allowed to rise above the rather low point which is most favorable to the growth of lettuce, since a higher temperature diminishes the vigor of the plant and at the same time favors the development of the fungus. Too high a night temperature is probably a common cause of the rapid progress of the disease. All diseased plants and all refuse on which the fungus can live and increase should be removed at once from the greenhouse and burned. For this purpose the boiler furnace is conveniently at hand. Every bit of vegetable remains should be often and scrupulously cleaned up and destroyed. A house which has been badly infested by the disease should be thoroughly cleaned, fumigated with burning sulphur and supplied with fresh soil, before a new season's crop is started. A coat of paint or whitewash over the whole interior may also be a useful precaution. With a house thus disinfected and a crop well nourished and well cared for, one may legitimately expect practical freedom from loss by rotting.

THE POWDERY MILDEW OF THE CUCUMBER. — *Erysiphe cichoracearum* DC.*

So far as I know, the first announcement of a powdery mildew on cucumbers, in America, was made in Bulletin No. 40 of this station in August last. It has long been known in Europe and has been observed in Australia. It is not known to me to attack cucumbers cultivated in the open air, but is probably not uncommon on plants forced in the greenhouse for a winter crop. It has been sent to this department by Dr. Jabez Fisher of Fitchburg and by Prof. L. H. Bailey of Cornell University, Ithaca, N. Y.

The disease ordinarily first appears on the upper surfaces of the leaves, and sometimes on the stems, of the host-plants, in the form of small, roundish, white spots, which have the peculiarly powdery appearance which has given to this group of fungi their name. These young spots suggest the effect of scattered splashes of flour upon the plant. Microscopic study shows that the white substance consists of the threads and spores of the parasite. The surface of the host-plant is covered by a close layer of flattened cells, the epidermis, and the vegetative threads of the parasite develop close to this outer surface. They are thus truly external, instead of ramifying among the internal cells of the host, as is the case with the cucumber mildew described in the last report of this station (p. 210), and with most parasitic fungi. The only penetration of the host by this fungus occurs where its creeping vegetative threads send out, from slight lateral projections, short branches which grow downward, piercing the outer walls of the epidermal cells and swelling into club-shaped bodies within the cavities of these cells. By means of these club-shaped organs, the *haustoria*, the parasite obtains its nourishment by the absorption of the contents of the invaded cells.

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* See note, p. 219.

The superficial threads grow and branch freely, and soon begin to send up erect, vertical threads, from which, after they have reached a certain length, spores are formed by the cutting off of the tip and of successively lower portions by consecutively formed cell-walls. Each oblong segment becomes, in its turn, rounded off at the angles and somewhat enlarged at the middle, and then falls from its support, ready for germination. On a well-developed thread one may thus see a chain of spores in all stages of development. These spores may vary considerably in size in specimens from the same source; but they do not usually, if ever, differ so widely as do those from Dr. Fisher's and Professor Bailey's specimens. Between the two there is a considerable difference in form as well as in size, which may point to a specific difference in the parasites from the two sources. The remarks concerning treatment of the disease of cucumbers will apply equally to both forms, whether they represent variations of the same species or not. These spores, when fully ripe, germinate readily in water, but do not develop far. Each gives rise to a germ-tube, usually near one of the original corners of the spore; but this tube rarely reaches a length greater than twice the short diameter of the spore. On nutrient gelatine, prepared with an infusion either of prunes or of cucumber leaves, the spores will develop no farther than in water; but in a drop of water on the surface of a living cucumber leaf they send a branch of the germ-tube downward, as a haustorium, into the underlying epidermal cell, and then grow and branch freely, until a considerable mycelium, forming a spot upon the leaf, is developed. From the readiness with which the leaf and stem and all succulent parts of the plant are attacked in this way, the disease spreads rapidly, or may be artificially communicated to healthy plants.

Under favoring conditions of heat and moisture the spots increase very rapidly in size and in numbers. Those upon a leaf may become confluent and involve the whole leaf. The attacked tissues soon become yellow and then brown and dry, and the plants are rendered worthless, if not utterly killed. The parasite is not limited in its attacks to weak or poorly nourished plants; but on strong and vigorous ones it often progresses more slowly, and less completely overcomes its host than when the latter is enfeebled from some other cause. This can readily be seen in plants grown respectively on poor and rich soils, but otherwise under similar conditions.

The structure of the summer-spore stage described shows plainly that this parasite is one of the *Powdery Mildews*, and heretofore its perfect or winter form has been unknown. It has therefore been impossible to say to what particular species of the group it should be referred. It has been known as the variety *Cucurbitarum* of *Oidium erysiphoides* Fries, which embraces various undetermined summer-spore stages of this group. But during last December, on several of the leaves of cucumber plants on which the disease had been allowed for six weeks to run its course, and which were covered by the summer spores of the fungus, there appeared smoky spots perhaps half an inch in diameter. On these spots were seen the young yellow and brown spore-fruits or *perithecia* of the winter stage. These soon reached maturity, and furnished the means for specific identification of the parasite. The dark-brown ripe perithecia are provided with irregular brownish appendages around their bases, and contain several spore-sacs each. Each spore-sac contains typically and most commonly two spores; but this number is often reduced to one, and less often rises to three or even four. A careful comparison of this fungus with the described species of the genus *Erysiphe*, to which it plainly belongs, shows it to agree in all essential details of structure, perithecia, haustoria, etc., with *E. cichoracearum* DC. The appendages of the perithecia are distinctly brown in mature specimens, but less deeply colored than is usually the case with those of this species developed in the open air. This difference may, however, well be due to the different conditions under which they have developed.

It is interesting to find that this parasite, so destructive under the given conditions, is the same with one of our commonest out-of-door species in summer and fall on various *Compositæ*, asters, golden-rods and sunflowers, on *Verbenas*, on *Phlox*, and on various other host-plants, to which it does comparatively little harm.

Professor Bailey and Dr. Fisher, as well as the writer, have found that this disease may be kept in check in the greenhouse by spraying the plants as often as is necessary with a solution of sulphide of potassium (liver of sulphur) in water, an ounce of the sulphide to four gallons of water. A stronger solution injures the plants and fruits. Spraying with the ammoniacal carbonate of copper has been found even more effective. But Professor Bailey finds more effective than either exposure to sulphur vapor. This is accomplished by closing the house as tightly as possible for half an hour or an hour at a time, while it is filled by the vapor arising from a vessel of sulphur kept a little above the melting point on a small oil stove. The vessel should be porcelain lined, to protect the iron from the action of the sulphur. This vapor appears to be harmless to the host-plants while fatal to surface parasites like the powdery mildews. Great care must be taken to avoid the ignition of the sulphur, since a few minutes' exposure to the fumes of burning sulphur would be fatal to a house full of plants; but, with reasonable care in protecting the sulphur from contact with the flame and in preventing the temperature from rising too high, there should be no danger of such a catastrophe.

A house in which this disease has been troublesome should be thoroughly disinfected by burning sulphur before a similar crop is again started. The soil should be entirely removed and replaced by fresh. But that removal of the earth is not alone sufficient has been clearly shown during the past season. The house in which the study of this disease was carried on during the winter and spring of 1891 remained dry and unused during August, and early in September the soil was wholly removed. New bottoms were put in the benches, which were then filled with fresh soil. A lot of new cucumber plants were started, and in October were abundantly and spontaneously attacked by the fungus in question. There is little doubt, however, that thorough fumigation will render a house clean, so far as fungi are concerned.

VARIOUS DISEASES.

A New Potato Disease. — Late in July last, Mr. G. D. Howe of North Hadley brought to the station some specimens of potato plants whose leaves bore spots in many respects strongly resembling those produced by the rot-fungus in the early stages of that disease. He reported that the disease was spreading over an extensive field and killing the plants. A visit to the field confirmed these statements, and showed that those plants which suffered most were those which were nearest maturity, although the foliage had not yet turned yellow from natural causes. Some rows of late potatoes, which were still vigorously growing and very green, although between infected rows, were almost free from the disease. The field had been lately sprayed as a protection against rot; and another spraying of certain rows was recommended, to test the possibility of checking the spread of the disease by this means. But its spread was so rapid that the plants were killed before time could be found to make the application. The tubers were not affected in any case beyond a probable slight loss of growth, and remained perfectly marketable. A pretty thorough and careful examination of the diseased leaves showed the constant presence in the spots of mycelium, from which were developed, on the lower surface of the leaves, spore threads and spores of the form-genus *Macrosporium.* This was clearly not simply a saprophytic form following the attack of some parasite, but occurred on the very young spots with a truly internal mycelium, and had all the appearance of a true parasite.

Circumstances made it impossible to study the disease further at the time; but it seems probable that we have here a new disease of potatoes which may prove of considerable importance. Mr. Howe is confident that the same disease attacked some of his potatoes in 1890, though in a less serious form. It attacked, during August, as Mr. Howe informs me, many other fields in Hadley, where it appears to have been quite general. The report from various parts of the State of the appearance of potato "blight" without the "rot" leads one to ask if this disease may not have been much more widely spread than is known; and the especial object of this note is to call the attention of others to it, and to ask readers of this report to forward at once to the station specimens of any potato plants which are observed to be attacked in this way. A careful watch will be kept in Hadley for the disease, and arrangements will be made to give it the attention it deserves should it reappear.

Another Disease of Cucumbers. — In connection with the study of the powdery mildew of the cucumber, above described, there were received from Dr. Jabez Fisher of Fitchburg specimens of cucumber plants which were attacked by a still more serious disease than the mildew, and one apparently much more difficult to control.

This disease is characterized by a dwarfed and stunted appearance of the shoots attacked. The young fruits become deformed and distorted, and some of the leaves which reach a considerable size, perhaps because they are attacked late, turn yellow and die. Sometimes a plant will push out a new and vigorous shoot which may grow for a time, but sooner or later is pretty sure to succumb. Over the lower surface of these yellow leaves may be seen, on close examination, a delicate, white, glairy film, which recalls by its appearance a very thin dried streak of some albuminous substance. Microscopic study of this film shows it to be a web of very fine interlacing fungus threads, closely adherent to the surface of the leaf. No spore formation was ever observed on the leaves as they come from the forcing-house; but when a fresh leaf, covered with a well-developed film, was placed in a moist chamber, the threads gave rise in two or three days to numerous short, erect stalks, irregularly scattered along their sides. These stalks taper somewhat toward their tips, which are rounded or slightly knobbed, and bear the elliptical or rather kidney-shaped spores of the fungus. These spores, when placed in water, swell up by absorption of water until they become nearly or quite spherical in form, and then germinate by extending a germ-tube nearly as large as the average of the vegetative filaments of the fungus. Lack of suitable material has prevented the culture of this fungus on nutrient media or attempts to inoculate cucumber plants with the fungus, but everything points to this fungus as the cause of the trouble.

From the description given it is evident that it is one of the numerous uncertain and little-known fungus forms; and, according to our present system of classification, it must be placed in or very near the form-genus *Acremonium*. Should the disease reappear the comming winter, special attention will be given to it and especially to the determination of its etiological relation to the disease in question.

The present incomplete note is here inserted as a preliminary record of a new disease of cucumbers and of what has been observed in connection with it, with the primary object of calling the attention of other pathologists and of growers of cucumbers under glass to it. It is especially requested that any person who observes this or any similar disease will promptly notify the writer of its presence, and send specimens and all possible details concerning its appearance and spread. Dr. Fisher states that this disease reduces the yield of badly attacked plants to ten per cent. of the normal. It seems difficult to combat, as it steadily increased in his houses in spite of applications of all the most efficient fungicides.

Rye Fungi. — The winter rye on the station plots was attacked severely by three fungi. In June many of the leaves showed the swelling and distorting effect of the leaf smut (*Urocystis occulta* Wallr.), further details concerning which will be found in another part of this report. It has not as bad a reputation and is not as well known as the grain smuts, but it undoubtedly does much harm in weakening the plant and so in reducing the production of both grain and straw.

At the same time with the smut there appeared in extensive orange patches on the leaves the summer spores of one of the grain rusts (*Puccinia rubigo-vera* (DC.) Wint.), so abundantly that they arose in clouds when the plants were shaken. Later the leaves of summer wheat on adjoining plots were very badly affected. In July this stage of the fungus had largely disappeared, and the leaves of the rye were blackened by the winter-spore pustules of the same fungus.

The life-histories of this and the related species of rusts are not yet fully understood, and our only protection at present is in destroying as completely as possible the stubble and all refuse which can harbor their spores in the field. Observations by the writer, made as his share in certain co-operative studies of the grain rusts, seem to indicate that this rust does not survive the winter in its host-plant, but depends upon fresh infection in the spring. On our plots the summer-spore pustules on rye seedlings survived the early frosts, and seemed vigorous until the heavy frosts and first snowfalls. The plots were then covered continuously by snow until spring. When they were again exposed, the discolored spots where the spore-pustules had been could be readily observed, and examination showed a mycelium to be present in the spot. But it was apparently dead, for repeated examination of the plots failed to detect new spores breaking out from any of these old spots. The fungus was not observed after growth was resumed until early in June, when a few warm and moist days increased the amount present from a few scattered spots to a general epidemic.

The virulence of this attack of rust caused a marked weakening of the plants, as was shown by the yellow color of their leaves and by the abundant presence upon the leaves — most abundant on the weakest ones — of the saprophytic fungus form known as *Cladosporium herbarum* (Pers.) Lk. The sooty patches of this with the orange masses of the rust pretty completely covered the leaves and left little or no normal tissue.

It is noteworthy, as illustrating the general principle repeatedly laid down in these reports, that on those plots which had been supplied with abundant and readily available nitrogen the effects of the fungi were much less serious than where the supply of nitrogen was deficient in quantity or in availability. The difference was especially striking in respect to the discoloration of the leaves, which was less in proportion to the amount of rust present on the well-fed plants.

The Club Root of Cabbages (*Plasmodiophora Brassicæ* Wor.) appeared for the first time on a part of the station grounds during the past season. The first specimens were obtained when the largest leaves were about six inches long. At this time, in the worst specimens the main root and its lateral branches were attacked and swollen into a nearly solid mass of the size of a hen's egg. The parts of the affected plants above ground did not at this time differ essentially in appearance from their neighbors, and were recognizable chiefly by the fact that in warm, sunny weather the foliage became wilted from the lack of sufficient root hairs on their swollen roots to absorb the necessary water to supply the demands of active transpiration. These plants failed entirely to form "heads," and were therefore rendered worthless by the disease. Microscopic examination of the diseased roots at different times showed the various stages in the development ot the parasite as they have been described and figured by Woronin.

Early in the season, just after the spring ploughing, soil was taken from a field which had been planted to cabbages the previous season and had produced a considerable number of "stump-footed" ones. This soil was placed in a flower-pot in the greenhouse and sown with cabbage seed. In due time some of the seedlings were attacked by the club root fungus in characteristic fashion, this showing the survival in the soil and their probable pretty general distribution through it, after ploughing, since a single flower-pot full taken at random contained at least several of them.

It is a matter of general observation among market gardeners and others that on some soils, especially heavy and moist ones, it is not profitable to plant cabbages two years in succession, on account of the prevalence of club root the second year. But it has also been remarked that two crops equally free from disease may be raised in one season. This fact is interesting as a practical demonstration of the fact that the spores of the club-root fungus are *resting spores*, and require a season of quiescence before they are able to germinate and reproduce the disease.

After a year or two of other than cruciferous crops (cabbages, turnips, radishes, etc.), the danger from the disease is past, and the latter may again be planted for a year.

The Blight of Celery, which forms spots on the leaves, is due to a parasitic fungus form which bears summer spores, known as *Cercospora Apii* Fres. That this represents merely an imperfect form of some fungus whose perfect form probably lives saprophytically, cannot be doubted; but no other form has thus far been connected with it. I have observed on celery, from the farms of Messrs. W. D. Philbrick of Newton Centre and A. H. Smith of West Springfield, that, after the brown blight spots have spread over the leaves and they have collapsed upon the ground, there appear upon them the tiny black pustules of one of the pycnidial forms known as *Septoria*. From the analogy of other cases and from the evidence of a series of specimens in different stages of the disease kindly sent by Mr. Smith, it is easy to believe that the *Septoria* form represents another stage in the history of the same fungus to which the Cercospora form belongs, although I have not been able to make cultures. One would, however, expect little additional evidence except from cultures of the perfect spore-form, which we do not yet know.

Since there have already been described several so-called species of *Septoria* on various umbelliferous plants which differ in no essential particulars from this form and from each other, it would be worse than superfluous to add here another to the already large list of names which have been given to what must eventually be shown to be a single form. And especially so since this form is undoubtedly merely an imperfect stage in the life cycle of some fungus for which, when its whole course of development is known, only a single name can stand; while the host of names inconsiderately given to its various imperfect forms will constitute only a cumbrous and useless synonymy. So far as it has been possible to examine material and descriptions, it appears that this form on celery is separated by no distinct features from the following previously described ones on *Umbelliferae*: *S. Sii* Rob. & Desm., *S. Cryptotaeniae* E. & Rau, *S. Saniculae* E. & E., *S. Dearnessii* E. & E. and *S. Petroselini* Desm.

Our form may be described as follows: Pycnidia appearing on the brown leaves after the coalescence of *Cercospora* spots, amphigenous, black, scattered, 100 to 160 mmm. in diameter; flattened when of the larger, globular when of the smaller, diameter; pycnospores somewhat curved, slightly tapering to both ends, usually 3-septate, rarely 2- or 4-septate, 24.-34. x 1.7-2. mmm.

It remains much to be desired that the perfect form of this fungus should be discovered. It will probably be found eventually on blighted celery leaves which have lain on the ground through the winter, or on rubbish near by, in spring.

Note. — Since the above was written Mr. F. D. Chester, of the Delaware Experiment Station, has described * what is doubtless this form as occurring on celery in that State, and thinks it may be that known in Europe as *Septoria Petroselini* Desm., var. *Apii* Briosi.

Clover Fungi. — Two fungi annually cause much damage to the clover on the station meadows and elsewhere in Amherst and in other parts of the State. One of these is the rust fungus (*Uromyces Trifolii* (Hedw.) Lév.), which is most harmful in its summer and winter spore stages, which are developed almost simultaneously in June and July. They appear in the form of pustules of different shades of brown, which burst through either surface of the leaf, and consist of the closely packed spores of the fungus.

The other fungus is the black mould (*Polythrincium Trifolii* Kze.), which appears in thickly scattered black spots over the under surface of the leaves. This form is often followed by the development of black crusts on the affected leaves, which have been named *Phyllachora Trifolii* Pers., and are supposed to represent the perfect form of the fungus; but the winter spores which should develop in them have never been described.

Both of these fungi reduce the fodder value of the clover to a minimum, and cause considerable reduction in the size of the leaves and in the general vigor of the plant, and are therefore real pests and sources of real loss.

A Fish-hatchery Fungus. — Early last spring I received from the Northampton fish-hatching establishment, through

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* Bulletin Torrey Bot. Club, December, 1891, p. 373.

Dr. J. B. Paige of the Agricultural College, specimens of trout eggs attacked by fungous filaments. These filaments were not in the fruiting stage; but when dead flies were thrown into the water containing the eggs, they were promptly attacked by similar filaments, which soon developed both non-sexual and sexual reproductive organs, from which the fungus was readily determined as *Achlya racemosa* Hild. I am informed by H. E. Maynard, Esq., of Northampton, that the eggs suffer most when first placed in the hatching trays. It is generally believed that only dead eggs are attacked; yet the fact, which is commonly observed, that, if the eggs are not removed from the trays as fast as they die, the fungus will extend to all the eggs, shows plainly that this cannot be the case. If it were able to attack only dead eggs, the fungus could not be a source of harm, and its presence in the trays could not endanger living eggs. It does not, as far as I can learn, attack the young fry after hatching.

The only effective means of preventing the spread of this affection lies in the frequent removal of all dead eggs from the hatching trays.

Rust of Poplars. — The European black poplar (*Populus nigra* L.) has been considerably planted on the grounds of the Agricultural College and elsewhere in Amherst.

The trees are attacked annually in September by the poplar rust (*Melampsora populina* (Jacq.) Lév.), and during the past two seasons the attacks have been very severe. The disease first shows itself in the yellowing of the lower leaves, due partly to the fading of their natural color in consequence of the presence of the parasite, and partly to the development on their lower sides of the abundant deep-yellow summer-spore masses of the rust. There now follows a definite upward progress of the disease, and when the middle part of the tree is reached, the lower leaves are falling in great numbers and the lower limbs soon become stripped of foliage. This results in two to three weeks after the first appearance of the disease. By the time they fall the leaves have become brown in color, from the further degeneration of their pigment and the replacement of the summer spores by the brown crusts of compacted winter spores. The leaves then lie upon the ground until spring, when the winter spores germinate and infect the new season's foliage.

It is evident that much of the harm done by this rust in rendering the trees unsightly and in causing premature defoliation can be avoided by thoroughly cleaning up and burning all the fallen leaves before snow falls, while the winter spores are still incapable of germination.

Anthracnose of Chestnut. — Since the cultivation of the chestnut is beginning to receive attention in some quarters, and bids fair to be attended with considerable success, it may be worth while to mention a fungus which, from its prevalence on wild chestnuts about Amherst, seems likely to prove troublesome to the cultivated plant. This fungus, which must be known as *Marsonia ochroleuca* (B. & C.), causes an anthracnose of the leaves in the form of small, thin, bleached spots, on which the spore pustules are formed. These spots are sometimes so abundantly developed as to cause the leaves to shrivel and die; and the fungus may be expected to do much greater harm to trees growing under the artificial conditions of cultivation.

The Black Knot of the Plum. — The study of this disease has been continued during the past year, both theoretically and practically. Some trees in an advanced stage of the disease have been put in charge of this department for treatment, and progress has been made in both lines of study. But the results obtained have not been so complete as was hoped for, partly on account of the limited material at my disposal and partly because a large amount of time was required for other studies reported here. Therefore it seems best to reserve the results obtained until they can be combined with those hoped for during the coming year, in a more complete and hence more satisfactory account.

Diseases of Tobacco. — This department has communicated with some leading tobacco growers in the Connecticut valley during the past fall, with a view to the investigation of the various diseases or affections to which tobacco is subject in the curing shed. These are known chiefly under three names, white vein, pole sweat and pole rot. How far these names represent affections due to distinct causes it is impossible to say, since they have apparently caused no loss in this State during the past season, and it has not been possible to obtain material for study. The purpose of the present note is to call the attention of tobacco growers to the fact that the department is desirous of studying the diseases named, and to ask them to notify the writer of the existence of any such in their barns next season. It seems very probable that much can be done towards a better understanding of the nature and means of prevention of these sources of loss. The writer desires here to thank those growers who have so promptly replied to his inquiries, and hopes to be as promptly informed of the existence of opportunities for the study of these diseases.

Preventive Treatment.

A somewhat extended account of the principles underlying the preventive treatment of fungous diseases of plants, with detailed directions for the preparation and application of the most efficient fungicides, was issued as Bulletin 39 of this station, in April last. That interest in this subject is being awakened was shown by the demand for the bulletin and for further information; but it is impossible to say to what extent its recommendations were acted upon, as very few persons have communicated to the department any report of such treatment or its results. The bulletin named can still be furnished, on request; but the more important points of the discussion are given below.

Since a plant which is once fairly attacked by a fungus is lost, treatment must be directed toward preventing the development of fungi upon the plants to be saved. Protective measures may be of two sorts; those which remove possible sources of infection from the plants, and those which fortify the plants against infection. The latter of these objects is accomplished by the use of *fungicides;* the former may be largely accomplished by *hygienic treatment.*

There are definite laws of health for plants as well as for animals, and in one case, as in the other, neglect of those laws invites disease. In the first place, plants which are expected to grow and thrive must be furnished with an abundance of the materials necessary to growth. Weak, poorly nourished plants suffer the attacks of parasites of all sorts, and have no power to resist them. Secondly, where a crop has suffered from a fungous disease in one season and a good crop of the same kind is desired in the following season, every tangible trace of the disease must be removed. For example, if a vineyard has suffered from *mildew* or *black rot*, all diseased leaves and berries should be collected at the end of the season with scrupulous care and wholly burned; and the same advice applies to a large list of cases. Thus incalculable numbers of the spores of the fungi of the respective diseases will be prevented from infesting the next season's crop. In some cases where the spores remain in the soil, as in the *stump foot* of cabbages or the *smut* of onions, the attacks of the disease can only be avoided by rotation with crops upon which the fungus in question cannot live. Thirdly, wild plants, which, being nearly related to a given cultivated one, may be subject to the same disease, or which bear a complementary spore form of a pleomorphic fungus, should be carefully excluded from the neighborhood of cultivated ones. Thus, wild cherries or plums, which are equally subject to the *black knot*, should be kept away from plum orchards; and spinach fields should be kept free of pig-weed, since both plants are attacked by the same *mildew;* and again, since red cedars bear one spore-form of a fungus whose other form is the *rust* of apple leaves, it is plain that they should not be allowed to grow near an apple orchard.

The importance of these preventives is often underrated by persons who understand and use successfully other forms of treatment. It is evident, however, that, in removing as completely as is possible the conditions which favor the abundance and increase of a fungus in the vicinity of its host plant, half the battle is won. When this has been done, we may protect the plants by the external application of *fungicides.*

These preparations, when properly prepared and when applied at the right times and in the right way, have been abundantly proved to be of the greatest value, and often to determine the difference between a full crop from plants on which they are used and practically no crop where they are not applied.

But the fact cannot be too strongly emphasized that everything depends upon how they are prepared, and upon *how* and *when* they are applied. The following pages attempt to give somewhat full instruction *how* to prepare and apply the most valuable fungicides, and such general hints *when* to apply them, as will be of service. The proper times for their application vary so much with special conditions, however, that instructions on this point must form an important part of the special directions for any particular case.

Preparation. — The protective quality of most of the best fungicides lies in the fact that they contain a certain proportion of copper; and, of the four recommended as applicable to most cases of fungous diseases, three contain it as the essential constituent.

The Bordeaux Mixture requires six pounds sulphate of copper, four pounds quicklime (fresh) and twenty-two gallons water. The sulphate of copper, known to the trade also as blue vitriol or blue-stone, is dissolved in two gallons of water. The solution will be hastened if the water be heated and the sulphate pulverized. After the solution is complete, fourteen gallons of water are added to it. The quicklime is slaked in six gallons of water, and stirred thoroughly until it forms a smooth, even mixture. After standing for a short time it is again stirred and added gradually to the sulphate solution, which is thoroughly stirred meanwhile. The mixture is then ready for use, though some experimenters recommend further dilution to twenty-five or thirty gallons, for certain uses. It should not be prepared until needed, and should be used fresh, as it deteriorates with keeping. Since the lime remains merely in suspension and is not dissolved, the mixture should be strained through fine gauze before entering the tank of the spraying machine, so that all of the larger particles which might clog the sprayer may be removed.

Ammoniacal carbonate of copper, in its improved form, is prepared from three ounces carbonate of copper, one pound carbonate of ammonia and fifty gallons water. Mix the carbonate of copper with the carbonate of ammonia, pulverized, and dissolve the mixture in two quarts of hot water. When they are wholly dissolved, add the solution to enough water to make the whole quantity fifty gallons. This preparation has been found to be better and cheaper than that made according to the original formula, which is as follows: Dissolve three ounces carbonate of copper in one quart aqua ammonia (22° B.),[*] and add the solution to twenty-five gallons of water.

Dr. Thaxter, formerly of the Connecticut Experiment Station, has suggested that a very large saving may be made by preparing the carbonate of copper by the following method, instead of buying it, as its market price is much greater than that of the materials necessary for its preparation: Take two pounds of sulphate of copper and dissolve it in a large quantity of hot water; in another barrel or tub dissolve two and one-half pounds of carbonate of soda (sal-soda) in hot water. When both are dissolved and *cooled*, pour the soda solution into the copper solution, stirring rapidly. There will result a blue-green precipitate of carbonate of copper, which must be allowed to settle to the bottom of the vessel. Now draw off the clear liquid above the sediment, fill the vessel with fresh water and stir up the contents thoroughly. After the copper carbonate has once more settled to the bottom, again draw off the clear fluid above. The carbonate may now be removed from the vessel and dried, when it is ready for use. From the amount of blue-stone and sal-soda given above will be produced one pound of copper carbonate, and the amount of each necessary to produce any given amount of copper carbonate is easily calculated.

Sulphate of copper is used in solutions of varying strength for certain special cases.

Sulphide of potassium, known also as sulphuret of potassium or liver of sulphur, has been found useful in the treatment of diseases caused by those fungi known as powdery mildews, especially on plants grown under glass. It is ordinarily used in the proportion of half an ounce of the sulphide to one gallon of water.

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[*] Dealers usually handle ammonia water of a strength of 24° B. (= 22.5% ammonia) or of 26° B. (= 26.5% ammonia). To reduce these to the required strength, 22° B. (= 19% ammonia), add *four* parts of water to *ten* of aqua ammonia of 26°, or *two* parts of water to *ten* parts of 24° aqua ammonia.

Materials. — For the convenience of persons who may wish to purchase the necessary materials for the preparation of fungicides, the writer has communicated with several reliable houses in some of the larger cities of the State, and has received from those named below favorable replies as to their readiness to fill orders promptly, and as to prices. He can, therefore, recommend these firms to persons wishing fungicide supplies, without in any respect implying that there are not many others equally reliable : —

Weeks and Potter Company, 360 Washington Street, Boston.
Messrs. E. & F. King, Boston.
Talbot Dyewood and Chemical Company 24 and 26 Middle Street, Lowell.
Jerome Marble & Co., Worcester.
Messrs. H. & J. Brewer, 463 Main Street, Springfield.

Concerning the cost of the various materials named above no very exact figures can be given, since prices vary with the state of the market and according to the quantity ordered. Prices per pound are considerably higher for small quantities than for larger ones, and the substances cost *much* less in original packages than in smaller lots. A large saving can be affected if several persons will combine in ordering what they need, both in the cost per pound of the chemicals and in cost of transportation. The following quotations may be given as the approximate prices of the various substances in *small* lots, at retail, and discounts from these prices will increase with the amount of the order : —

	Cents per Pound.
Copper sulphate,	8
Copper carbonate,	60
Ammonium carbonate,	15
Sodium carbonate,	3
Aqua ammonia (24°),	10
Potassium sulphide,	25

Application. — In the case of diseases caused by fungi which spread from plant to plant during the growing season, the necessary protection is afforded by applying the fungicides in the form of a very fine spray to the surface of the plants until they are thoroughly wetted. This, drying, leaves a thin film over the plants, which is fatal to fungus spores that may fall upon it. Suitable spraying apparatus is of the first importance to success in the use of fungicides, especially a nozzle which shall allow the escape of only the finest spray. The ordinary spraying nozzles used with hose or with small hand pumps are utterly unsuited to this purpose. The best form is, perhaps, that known as the Vermorel nozzle, which is furnished with many pieces of apparatus, or may be purchased separately. This nozzle gives a very fine and steady spray, which may be instantly cut off, and is the best suited for the Bordeaux mixture, since it has an attachment for promptly freeing it of clogging particles. Another excellent nozzle for the other fungicides described, which are clear solutions, is the Nixon nozzle.

For supplying the necessary pressure to drive the liquid through the nozzle in the form of spray, some form of force pump is necessary. The form chosen must depend on the amount of work to be done and the character of the plants to be treated. We may distinguish three general types. The *knapsack* type is suitable for almost any small job, the importance of which does not justify the purchase of a more expensive apparatus, and is especially adapted to use upon low-growing plants cultivated in hills or rows. These machines have a tank holding a few gallons with a pump worked by a lever with one hand, while the other hand directs the nozzle, the apparatus being strapped upon the back of the operator. The *hand-cart* type of pump consists of a large reservoir, representing the body of the cart, connected with a force pump, and the whole mounted on two or three wheels with a handle for pulling or pushing. The *horse-cart* type of machine includes a larger reservoir and more powerful pump, capable of throwing several streams, mounted on wheels, to be drawn through the field or orchard by horsepower.

For information concerning the details and prices of the numerous spraying machines on the market, the reader is referred to the catalogues, which will be sent on application, of the Nixon Nozzle and Machine Company, Dayton, O.; The Goulds Manufacturing Company, Seneca Falls, N. Y.; Albinson & Co., 2026 Fourteenth Street, Washington, D. C.;

Adam Weaber and Son, Vineland, N. J.; Rumsey & Co., Seneca Falls, N. Y.; Field Force Pump Company, Lockport, N. Y., or W. & B. Douglas, Middletown, Conn.

When to Apply. — As has been said, this question is of the first importance in dealing with any disease, but the answer varies with the case in hand. In general, however, let it be remembered that all treatment is preventive, that plants once attacked are lost, and that spraying must therefore be prompt and early. In the case of a disease of an herbaceous crop like potatoes, the first spraying should be given *at once* on the appearance of the disease in any part of the field or a neighboring field. The same applies to diseases of woody plants which have previously been free from disease; but where grapes or apples, for instance, were attacked last year, treatment should begin with the beginning of growth, and should proceed on the assumption that the disease will reappear if not prevented. In any case, after spraying is begun it must be repeated until danger is past, — a very variable period, — at intervals which may average ten days or two weeks, but will vary according to circumstances, depending especially on the amount of rainfall, which washes the copper salts from the plants and renders a new application necessary. It is always best to leave an occasional plant or row of plants untreated among the treated ones to furnish a basis for judgment as to the efficacy of the treatment.

Quantities Needed. — It is very difficult to give any statement of the amount of a fungicide required to properly spray any of the various plants on which it may be used.

The size and leaf surface of plants of the same kind vary so much with their age, the conditions of cultivation, and other controlling factors, that it is hardly possible to say what is an average plant of any sort. Besides this, very few experimenters have published statements as to the quantities used in their work. Yet one of the first questions asked by a beginner is, "How much do I need?"

With these facts understood, the following figures may be given as approximate statements of the amount of a preparation required for properly spraying the crops named, when a suitable and economical nozzle is used. For another plant the amount can be roughly estimated by a comparison of its leaf surface with that of one of these; For apple-trees, one and one-half to two gallons to a good-sized tree; for grapevines, one gallon to six or eight well-grown vines; for potatoes, one hundred to one hundred and twenty-five gallons per acre.

A Caution. — Certain observations of the writer and certain well-known incidents in the fruit trade during the past season show that the use of fungicides, like every other good thing, may be carried to extremes by inexperienced or incautious beginners or by over-zealous friends. It is undeniably true that the free use of copper preparations has been recommended far too promiscuously and too inconsiderately in certain quarters for every fungous ill which vegetable "flesh is heir to." It is, or ought to be, self-evident that, on plants whose foliage is to be eaten, like lettuce, these preparations should *never* be used. On plants like the potato, which are cultivated for subterranean parts, their use is perfectly safe; while to fruit-trees and vines the Bordeaux mixture, at least, should not be applied after the fruit has begun to ripen. If, from its nature or through favoring conditions, a disease makes its appearance after the fruit has begun to color, much can be done to prevent its spread by removal of diseased parts and rigid hygienic precautions. But, from the point of view of profit and loss alone, it is not worth while to save a crop to be seized by some vigilant board of health, which can afford to err only on the side of safety. Our present methods of treatment, while sufficient and unobjectionable for certain cases, must be regarded as only temporary and for the present better than nothing, in many other cases. For many diseases our only remedy yet known is quite as bad as the disease, and it is not to be expected that public sentiment will long tolerate the use of poisonous insecticides and fungicides where such use involves any possible danger.

Some Experiences. — The responses to the offers of assistance contained in this bulletin, while not so numerous as they should have been, were yet encouraging. They show that our most progressive farmers and gardeners are beginning to appreciate what this department is glad to do for them. It is not known to what extent many of those who wrote for further information and advice practically applied it; but reports have been received from some which speak for themselves. Such is that of Mr. J. N. Pardee of South Billerica, who sprayed his apple trees only twice with Bordeaux mixture, containing Paris green, once on the 1st and once on the 13th of June. In each case the spraying was followed, the next day, by a heavy shower. Thinking the rains must have washed off the combined fungicide and insecticide, and that it was too late for further treatment to be effective, he did nothing more. Concerning results, he writes: "The fruit from the sprayed trees and parts of trees did not drop off as freely as from the unsprayed trees, and is uniformly fair, with clean, smooth skin, and two-thirds grade as choice No. 1, while the other third brings a good price as seconds. It is fair, but wormy. The fruit from the unsprayed trees and parts of trees is almost uniformly covered with black spots. The sound apples will not grade as first-class No. 1, while the wormy apples go for cider, and less than one-third of the fruit is sound. As all other conditions, soil, care, etc., have remained the same, I do not know what to attribute the difference to, except to the spraying. The cost of the material for the two sprayings was about fifteen cents per tree, and the time taken to spray thirty trees twice was about three hours for two men and a horse." It is evident that the secret of the efficacy of this slight treatment is to be found in the fact that it was applied at just the right time in the development of the fruit, and that the preparation was not washed off by the rains which immediately followed its application.

Mr. N. E. Baker of Lawrence has sprayed his carnations with the improved form of ammoniacal carbonate of copper both before and since putting them in the house, as a protection against the leaf-spot fungus (*Septoria Dianthi* Desm.), and reports that the new growth is vigorous and healthy.

These examples serve to show what may fairly be expected from the proper use of fungicides well applied, and it is hoped that they may encourage many others to try them next season. As a further stimulus in this direction it is proposed to give annually in these reports special detailed instructions for the treatment of some group of diseases caused by fungi whose life histories are so similar that the same directions will apply to all. The symptoms of each disease and its effect on the diseased plants will be described, and enough of the life history of the parasite will be given to make clear the reasons for the treatment prescribed.

The group chosen for the present report is one of the best known as to the life history of its members, some of which are among the most easily avoided of all the fungi. It will, therefore, serve as an excellent introduction to the subject. Furthermore, the simplicity of the preventive treatment for some of these diseases will serve to tempt the reader to undertake it, and its striking efficacy will encourage the beginner to try the more laborious treatment for other troubles. The diseases in question are those known as SMUTS. (See Plate I.)

Of the large number of smut fungi which attack plants of all sorts, the number of those which are sources of loss to Massachusetts farmers to such an extent as to deserve mention here is five or six. They are those which cause the diseases known as the loose smuts of oats, barley and corn, and the leaf smuts of rye and of onions.

The loose smuts are peculiarly harmful, because the black smut-masses are formed only in the seeds or grains, the very part for which the plants are cultivated. These smuts of oats, barley and wheat have been regarded until lately as belonging to a single species known as *Ustilago segetum* (Bull.) Ditm.; but those who have studied them most carefully now consider that they include four species, distinguished by differences in spore germination, and by their restriction to particular hosts and their inability to attack others. They are called respectively *Ustilago Avenae* (Pers.), on oats, *U. Hordei* (Pers.) and *U. nuda*, (Jensen) K. & Sw., on barley, and *U. Tritici* (Pers.), on wheat. As the *oat smut* has been studied most and is best known, and is also perhaps the form which causes most loss in Massachusetts, it may be described here as a general type (Fig. 1.)

This fungus can penetrate only the very young tissues of its host plant, and is harmless to tissues whose outer cell walls have begun to harden. To be effective, the fungus-threads must reach the growing tip of the host and develop with it; thus giving no sign of their presence until the plant is well grown and the heads are formed. But the growing point can only be reached when the very young seedling is attacked; therefore all attacks at a late period in the life of the host are soon overcome and outgrown. Now the tuft of hairs or "beard" and the "hulls" of the grain afford very convenient lodging places for smut spores, which are thus sown with the seed, germinate with it, and are ready to attack the young seedling at just the time when their attack is most effectual. Besides, these spores germinate most freely in fresh manure, and produce multitudes of germs which can attack the host plant under favorable circumstances. As it is probable that the spores can pass through the animal body unharmed, the manure from animals which have eaten smutted grain must be a very important source of infection. But it has been shown that the reproductive power of these germs becomes exhausted in the course of a year in manure; therefore old and well rotted manure, while otherwise better for the crop, is also harmless as a carrier of disease.

Professor Kellerman, formerly of the Kansas Agricultural College, has estimated that in Kansas the average annual loss of oats from this disease is equal to six or seven per cent. of the crop, and there is no reason to suppose that this estimate is too high for our own State. On the basis of the statistics of the United States Department of Agriculture this would give an annual loss in Massachusetts of $20,000 from this single smut. Nearly the whole of this amount might very easily be saved, if our farmers would apply the very simple treatment which will certainly limit the disease to an occasional stalk. This consists in soaking the seed for fifteen minutes in hot water, kept at a temperature of 132° F., or for twenty-four hours in a solution of one pound of potassium sulphide (liver of sulphur) in twenty-four gallons of water. Neither of these treatments injures the seed, but, on the contrary, distinctly increases the crop.

Of the *barley smuts* (Fig. 2) one seems to yield readily to the same treatment, while the other seems not to be prevented by it; but, as both forms commonly occur on the same field, at least a considerable decrease in the loss from smut may be expected to follow the treatment of barley with hot water before planting.

Wheat is not a crop of sufficient importance in Massachusetts to make any extended mention necessary here. It is subject not only to the loose smut mentioned above (Fig. 3), but also to the so-called hard or stinking smut or "Bunt" (*Tilletia* sp., Fig. 6). The latter of these is completely controlled by the hot-water treatment, but the former seems not to be affected by it.

A few practical directions for applying the hot-water treatment may be useful here. The seed should first be thoroughly wetted in cold water, and all imperfect seeds and other bodies which float on the top skimmed off. Two kettles of water should be provided, that in one at a temperature of 110° to 120°, and that in the other at the temperature required for the treatment, 132°. The latter should be kept as nearly as possible at the same temperature throughout the treatment, by the addition of hot or cold water whenever the thermometer shows it to be necessary. The seed is taken in lots of perhaps half a bushel at a time in a basket of wire gauze or a bag of very loosely woven material, and plunged first into the cooler water, lifted out and plunged again until it is thoroughly wetted and warmed. This is important, that the seed may not cool the hotter water too much. Now the basket or bag is transferred to the latter and allowed to remain fifteen minutes, during which it is occasionably lifted and lowered and turned about, to ensure the complete wetting of every grain. When the seed is removed it is quickly cooled with cold water and spread out until it is dry enough to be sown.

In the case of the *corn smut* it is not merely the young grains which are attacked, but the pustules may be found upon any part of the plant; and an infection of any part sufficiently young to be penetrated by the fungus gives rise in a few weeks to smut pustules. Thus the plant is not beyond liability to infection until all its tissues are hardened; that is, until the "tassel" appears.

The only treatment for this trouble which can be confidently recommended is the prompt removal and destruction of all smutted parts as soon as they appear. It should hardly be necessary to call attention to the fact that to throw them into the compost heap is not to destroy them, but is often the surest means of perpetuating and disseminating the disease.

Fig. 5 shows a portion of a "tassel" of corn attacked by smut.

The leaf-smut of rye (Fig. 4) forms its black masses on the leaves and stems of rye, which are often considerably distorted by it. It does not, therefore, cause a direct loss of grain, but indirectly reduces the crop by weakening the plants which are attacked.

The same is true of the *onion smut*, which forms its pustules on both leaves and bulbs, and commonly kills its host. If the attack is not too severe, however, the plant may recover, though greatly weakened and never producing a strong bulb. It appears that only the young seedlings are susceptible to attack. This smut is propagated by means of the soil, and its spores may retain their vitality in the earth for several years. Treatment must consist in sowing with the onion seed some fungicidal substance which shall prevent the development of the smut spores in its vicinity, and the consequent infection of the seeding onions. The substance which gives most promise in this line at present is flowers of sulphur, although its protective effect is not all that can be desired. When a field becomes badly infected it should be used for some other crop, and the onion crop transferred to fresh ground for several years, at least.

For the assistance of any who may not feel certain as to the identify of the diseases here discussed, a plate is appended showing the characteristic appearance of the various smuts here mentioned, except that of onions. This plate was made from a photograph taken directly from specimens of diseased plants, and shows the effects of the various fungi on their respective host plants very clearly. With its help one should be able to identify the diseases represented without doubt.

EXPLANATION OF PLATE I.

Appearance of Some Smut Diseases.

(All figures of natural size.)

Fig. 1. Loose Smut of Oats, *Ustilago Avenæ* (Pers.) Jens.

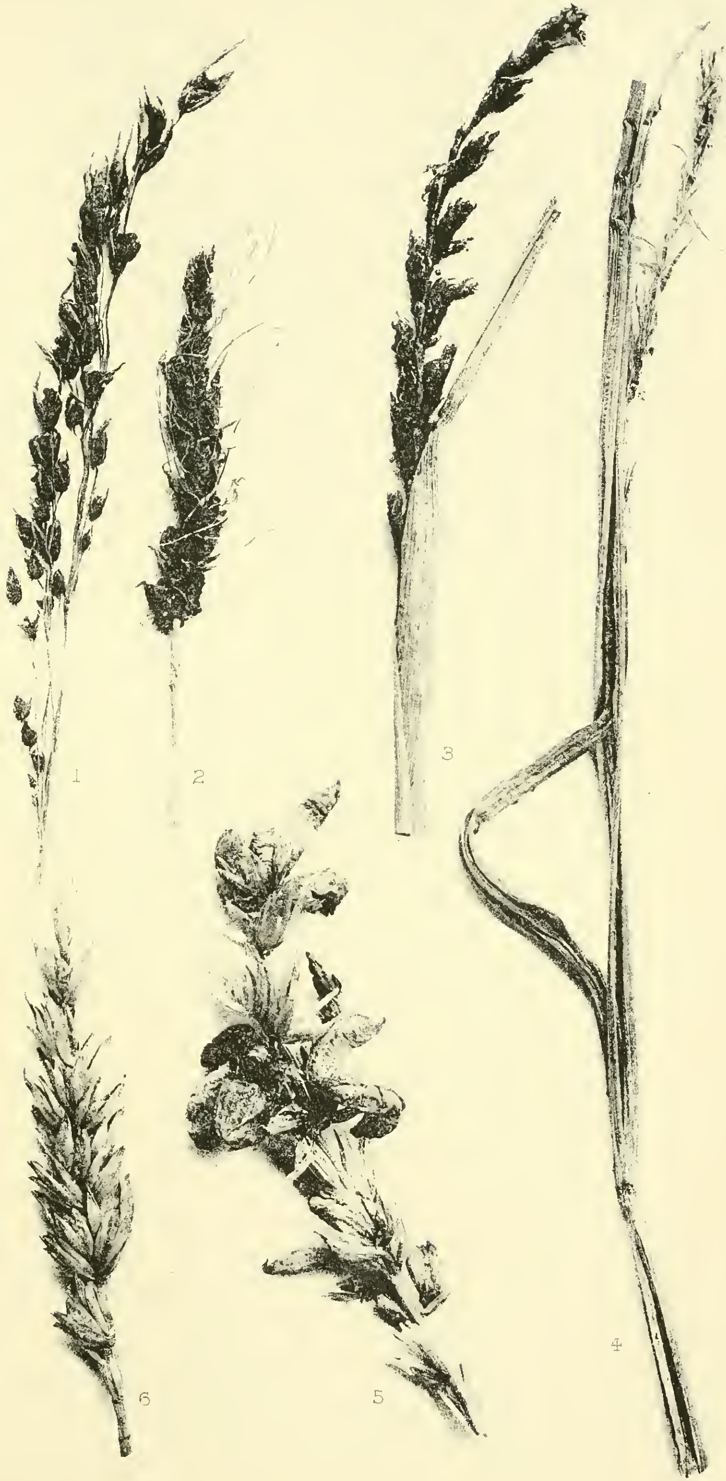
Fig. 2. Loose Smut of Barley, naked form, *U. nuda* (Jens.) Kell. & Sw.

Fig. 3. Loose Smut of Wheat, *U. Tritici* (Pers.) Jens.

Fig. 4. Leaf Smut of Rye, *Urocystis occulta* (Wallr.) Rabh.

Fig. 5. Smut of Corn in the staminate flowers or "tassel," *Ustilago maydis* (DC.) Cda.

Fig. 6. Stinking Smut or "Bunt" of Wheat, *Tilletia fœtens* (B. & C.) Trel.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PART III.

SPECIAL WORK IN THE CHEMICAL LABORATORY.

I. COMMUNICATION ON COMMERCIAL FERTILIZERS:—
  1. GENERAL INTRODUCTION.
  2. LAWS FOR THE REGULATION OF TRADE IN COMMERCIAL FERTILIZERS.
  3. LIST OF LICENSED MANUFACTURERS FOR MAY 1, 1890, TO MAY 1, 1891.
  4. ANALYSES OF LICENSED FERTILIZERS.
  5. ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.
  6. MISCELLANEOUS ANALYSES.

II. WATER ANALYSES.

III. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF AGRICULTURAL CHEMICALS AND REFUSE MATERIALS USED FOR FERTILIZING PURPOSES.

IV. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF FODDER ARTICLES, FRUITS, SUGAR-PRODUCING PLANTS, DAIRY PRODUCTS, ETC.

I. COMMUNICATION ON COMMERCIAL FERTILIZERS.

1. General introduction.
2. State laws for the regulation of the trade in commercial fertilizers.
3. List of licensed manufacturers and dealers for May 1, 1890, to May 1, 1891.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.

1. General Introduction.

The sale of commercial manurial substances, compound and simple, has been quite active in our State. Forty-eight manufacturers and dealers have applied and received a license for the sale of their various brands in our State. Twenty-six of them are residents of other States.

One hundred and ninety-two samples of licensed articles have been collected in all parts of the State by a duly authorized agent of the station. One hundred and fifty-eight of them have been carefully analyzed at the chemical laboratory of the station with the following results: six samples contained all three essential constituents above the highest guarantee; eighteen samples contained two of the essential constituents above the highest guarantee; forty-two samples contained one of the essential elements above the highest guarantee; sixty-one samples contained all three essential elements at the lowest guarantee; fifty samples contained two elements at the lowest guarantee; thirteen samples contained one element at the lowest guarantee; no samples contained all three essential elements below the stated lowest guarantee; nine samples contained two elements below the stated lowest guarantee; forty-two samples contained one element below the lowest stated guarantee.

The deficiency in one or two essential constituents was in the majority of instances compensated for by an excess in the others. The variations in the market price of the various prominent fertilizer constituents have been during the year within the usual limits. The most serious fluctuations were noticed in case of Chili saltpetre, nitrate of sodium, with a slight advance for corresponding months.

The duties assigned to the director of the station, to act as inspector of commercial fertilizers, render it necessary to *discriminate* in official publications of the results of analyses of commercial fertilizers and of manurial substances in general made at the station, *between analyses of samples collected by a duly qualified delegate of the experiment station, in conformity with the rules prescribed by the new laws, and those analyses which are made of samples sent on for that purpose by outside parties.* In regard to the former alone can the director assume the responsibility of a carefully prepared sample, and of the identity of the article in question.

The official report of analyses of compound fertilizers and of all such materials as are to be used for manurial purposes, which are sold in this State under a certificate of compliance with the present laws for the regulation of the trade in these articles, has been restricted by our State laws to a statement of chemical composition and to such additional information as relates to the latter.

The practice of affixing to each analysis of this class of fertilizers an approximate commercial valuation per ton of their principal constituents has, therefore, been discontinued. This change, it is expected, will tend to direct the attention of the consumers of fertilizers more forcibly towards a *consideration of the particular composition of the different brands of fertilizers offered for their patronage, a circumstance not unfrequently overlooked.*

The *approximate market value* of the different brands of fertilizers obtained by the current mode of valuation does not express *their respective agricultural value*, i. e., their crop-producing value; for the higher or lower market price of different brands of fertilizers does not necessarily stand in a direct relation to their particular fitness, without any reference to the particular condition of the soil to be treated and the special wants of the crops to be raised by their assistance.

To select judiciously from among the various brands of fertilizers offered for patronage requires, in the main, two kinds of information; namely, we ought to feel confident that the particular brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost, and that it contains them in such form and such proportions as will best meet existing circumstances and special wants. In some cases it may be mainly either phosphoric acid or nitrogen or potash; in others, two of them; and in others again, all three. A remunerative use of commercial fertilizers can only be secured by attending carefully to the above-stated considerations.

To assist farmers not yet familiar with the current mode of determining the commercial value of manurial substances offered for sale in our markets, some of the essential considerations, which serve as a basis for their commercial valuation, are once more stated within a few subsequent pages.

The hitherto customary valuation of manurial substances is based on the average trade value of the essential fertilizing elements specified by analysis. The money value of the higher grades of agricultural chemicals and of the higher-priced compound fertilizers depends, in the majority of cases, on the amount and the particular form of two or three essential articles of plant food, i. e., phosphoric acid, nitrogen and potash, which they contain. To ascertain by this mode of valuation the approximate market value of a fertilizer (i. e., the money worth of its essential fertilizing ingredients), we multiply the pounds per ton of nitrogen, etc., by the trade value per pound; the same course is adopted with reference to the various forms of phosphoric acid and of potassium oxide. We thus get the values per ton of the several ingredients, and, adding them together, we obtain the total valuation per ton in case of cash payment at points of general distribution.

The market value of low-priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barnyard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation, and more or less advantageous mechanical condition for a speedy action, exert, as a rule, a decided influence on their selling price.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers, when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from fifty to one hundred per cent. in commercial value, on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals (1891).

	Cents per Pound.
Nitrogen in ammoniates, ...	18½
Nitrogen in nitrates,*	14½
Organic nitrogen in dry and fine ground fish, meat, blood,	15½
Organic nitrogen in cotton-seed meal and castor pomace, .	15
Organic nitrogen in fine-ground bone and tankage, . .	15
Organic nitrogen in fine-ground medium bone and tankage,	12
Organic nitrogen in medium bone and tankage, . .	9½
Organic nitrogen in coarser bone and tankage, . . .	7½
Organic nitrogen in hair, horn shavings and coarse fish scraps, ...	7
Phosphoric acid soluble in water, ...	8
Phosphoric acid soluble in ammonium citrate, . . .	7½
Phosphoric acid in dry ground fish, fine bone and tankage,	7
Phosphoric acid in fine medium bone and tankage, . .	5½
Phosphoric acid in medium bone and tankage, . . .	4½
Phosphoric acid in coarse bone and tankage, . . .	3
Potash as high-grade sulphate, and in forms free from muriate or chlorides, ashes, etc., ...	5½
Potash as kainite, ...	4½
Potash as muriate, ...	4½

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* The price of nitrate of soda has of late advanced, on account of the civil war in Chili.

The organic nitrogen in *superphosphates, special manures and mixed fertilizers of a high grade* is usually valued at the highest figures laid down in the trade values of fertilizing ingredients in raw materials, namely, fifteen and a half cents per pound; it being assumed that the organic nitrogen is derived from the best sources, viz., animal matter, as meat, blood, bones, or other equally good forms, and not from leather, shoddy, hair, or any low-priced, inferior form of vegetable matter, unless the contrary is ascertained. The insoluble phosphoric acid is valued in this connection at two cents.

The above trade values are the figures at which, in the six months preceding March, 1891, the respective ingredients could be bought at *retail for cash in our large markets, in the raw materials*, which are the regular source of supply.

They also correspond to the average wholesale prices for the six months ending March 1, plus about twenty per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to agree fairly with the retail price at the large markets of standard raw materials, such as: —

Sulphate of ammonia,
Nitrate of soda,
Muriate of potash,
Sulphate of potash,
Dried blood,
Dried ground meat,
Dry ground fish,
Azotin,
Ammonite,
Castor pomace,
Bone and tankage,
Plain superphosphates.

A large percentage of commercial materials consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary characters of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

Consumers of commercial manurial substances do well to buy, whenever practicable, on guarantee of composition with reference to their essential constituents, and to see to it that the bill of sale recognizes that point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent.

Our present laws for the regulation of the trade in commercial fertilizers include not only the various brands of compound fertilizers, but also all materials, single or compound, without reference to source, used for manurial purposes, when offered for sale in our market at ten dollars or more per ton. Copies of our present laws for the regulation of the trade in commercial fertilizers may be had by all interested, on application, at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

2. *The Provisions of the Act are as follows:*

[Chapter 296.]

An Act to regulate the sale of commercial fertilizers.

Be it enacted, etc., as follows:

Section 1. Every lot or parcel of commercial fertilizer or material used for manurial purposes sold, offered or exposed for sale within this Commonwealth, the retail price of which is ten dollars or more per ton, shall be accompanied by a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent in ammonia, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials, said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

Sect. 2. Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within the state of Massachusetts, shall file with the director of the Massachusetts agricultural experiment station, a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SECT. 3 The manufacturer, importer, agent or seller of any brand of commercial fertilizer or material used for manurial purposes, the retail price of which is ten dollars or more per ton, shall pay for each brand, on or before the first day of May annually, to the director of the Massachusetts agricultural experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand or fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of said analysis fees and statement specified in section two, the director of said station shall issue certificates of compliance with this act.

SECT. 4. No person shall sell, offer or expose for sale in the state of Massachusetts, any pulverized leather, raw, steamed, roasted, or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure and to accompany or go with every parcel or lot of the same.

SECT. 5. Any person selling, offering or exposing for sale, any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence, and one hundred dollars for each subsequent offence.

SECT. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use, and not to sell in this state.

SECT. 7. The director of the Massachusetts agricultural experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or material used for manurial purposes to be made annually, and publish the results monthly, with such additional information as circumstances advise: *provided*, such information relates only to the composition of the fertilizer or fertilizing material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the director or his deputy and by the party or parties in interest or their representatives present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station; but it shall be the duty of said director, upon ascertaining any violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of the fertilizer or fertilizing material if the same shall be found substantially equivalent to the statement of analysis made by the manufacturer or importer.

Sect. 8. Sections eleven to sixteen inclusive of chapter sixty of the Public Statutes are hereby repealed.

Sect. 9. This act shall take effect on the first day of September in the year eighteen hundred and eighty-eight. [*Approved May 3, 1888.*]

Instructions to Manufacturers, Importers, Agents and Sellers of Commercial Fertilizers or Materials Used for Manurial Purposes in Massachusetts.

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this State must be accompanied: —

First, with a distinct statement of the name of each brand offered for sale.

Second, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

Third, with the fee charged by the State for a certificate, which is five dollars for each of the following articles: nitrogen, phosphoric acid and potassium oxide guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers but to all substances, single or compound, used for manurial purposes, and offered for sale at ten dollars or more per ton of two thousand pounds.

3. The certificate must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they desire, after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

7. All applications for certificates ought to be addressed to the Director of the Massachusetts State Agricultural Experiment Station.

Arrangements are made, as in previous years, to attend to the examination of objects of general interest to the farming community, to the full extent of existing resources. Requests for analyses of substances — as fodder articles, fertilizers, etc. — coming through officers of agricultural societies and farmers' clubs within the State will receive hereafter, as in the past, first attention, and in the order that the applications arrive at the office of the station. The results will be returned without a charge for the services rendered. Application of private parties for analyses of substances, free of charge, will receive a careful consideration whenever the results promise to be of a more general interest. For obvious reasons, no work can be carried on at the station of which the results are not at the disposal of the managers for publication, if deemed advisable in the interest of the citizens of the State.

All parcels and communications sent to "The Massachusetts State Experiment Station" must have express and postal charges prepaid, to receive attention.

3. *List of Dealers who have secured Certificates for the Sale of Commercial Fertilizers in this State during the Past Year, and the Brands licensed by Each.*

Ames Fertilizer Company, Peabody, Mass.: —
  Animal Fertilizer.

E. Frank Coe, New York, N. Y.: —
  High-grade Ammoniated Bone Superphosphate.
  Gold Brand Excelsior Guano.
  Potato Fertilizer.
  Blue Brand Excelsior Guano.
  Red Brand Excelsior Guano.

Cleveland Linseed Company, Worcester, Mass.: —
  Steam-cooked Linseed Meal.

H. J. Baker & Bro., New York, N. Y.: —
  A. A. Ammoniated Superphosphate.
  Pelican Bone Fertilizer.
  Special Potato Manure.
  Special Grass Manure.

Whittemore Bros., Wayland, Mass.: —
  Whittemore's Complete Manure.

J. M. Butman, Lowell, Mass.: —
  Lowell Bone Fertilizer.

Edmund Hersey, Hingham, Mass.: —
  Ground Bone.

J. A. Tucker & Co., Boston, Mass.: —
  Original Bay State Bone Superphosphate.
  Imperial Bone Superphosphate.

J. C. Dow & Co., Boston, Mass.: —
  Nitrogenous Superphosphate.
  Ground Bone Fertilizer.
  Fine-ground Bone.

Cumberland Bone Company, Portland, Me.: —
  Cumberland Bone Superphosphate.
  Seeding-down Fertilizer.
  Potato Fertilizer.

3. *List of Dealers who have secured Certificates, etc.* — Continued.

C. A. Bartlett, Worcester, Mass.: —
    Pure Ground Bone.
    Animal Fertilizer.

Leander Wilcox, Mystic Bridge, Conn.: —
    Dry Ground Fish Guano.
    Potato Manure.
    Ammoniated Bone Superphosphate.
    High-grade Fish and Potash.

W. E. Fyfe & Co., Clinton, Mass.: —
    Unleached Wood Ashes.

Daniel T. Church, Tiverton, R. I.: —
    Fish and Potash.
    Church's Special.
    Church's Standard.
    Pure Dry Ground Menhaden Guano.

Williams & Clark Fertilizer Company, Boston, Mass.: —
    Americus Superphosphate.
    Potato Phosphate.
    Bone Meal.
    High-grade Special.
    Tobacco Grower.
    Sulphate of Potash.
    Muriate of Potash.
    Dry Ground Fish.

Cleveland Dryer Company, Boston, Mass.: —
    Cleveland Potato Phosphate.
    Cleveland Superphosphate.

W. D. Stewart & Co., Boston, Mass.: —
    Soluble Pacific Guano.
    Special Potato Manure.

Munroe, Judson & Stroup, Oswego, N. Y.: —
    Unleached Canada Wood Ashes.

N. Ward Company, Boston, Mass.: —
    High-grade Animal Fertilizer.

Lister's Agricultural Chemical Works, Newark, N. J.: —
    Standard Fertilizer, Success.
    Ammoniated Dissolved Bone Phosphate.
    Potato Fertilizer.
    Ground Bone.

3. *List of Dealers who have secured Certificates, etc.* — Continued.

G. E. Holmes, Worcester, Mass. : —
    Steamed Bone.

A. Lee & Co., Boston, Mass. : —
    Lawrence Fertilizer.
    Ground Bone.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y. : —
    New Rival Ammoniated Superphosphate.
    Buffalo Superphosphate, No. 2.
    Special Potato Manure.
    Pure Ground Bone.
    Ammoniated Bone Superphosphate.
    Potato, Hop and Tobacco Phosphate.
    Queen City Phosphate.
    Vegetable Bone Superphosphate.
    Wheat and Corn Phosphate.
    Niagara Phosphate.
    Ammoniated Practical Phosphate.

F. C. Sturtevant, Hartford, Conn. : —
    Tobacco and Sulphur Fertilizer.

Read Fertilizer Company, Syracuse, N. Y. : —
    H. G. Farmers' Friend.
    Standard Phosphate.
    Bone, Fish and Potash.
    Strawberry and Small Fruit Special.

Bradley Fertilizer Company, Boston, Mass. : —
    X. L. Phosphate.
    B. D. Sea-fowl Guano.
    Coe's Original Superphosphate of Lime.
    Fish and Potash.
    Pure Fine-ground Bone.
    Bradley's Complete Manures : —
        For Potatoes and Vegetables.
        For Corn and Grain.
        For Top-dressing Grass and Grain
    Bradley's Potato Manure.
    Nitrate of Soda.
    Sulphate of Ammonia.
    Muriate of Potash.
    Dissolved Bone-black.

3. *List of Dealers who have secured Certificates, etc.* — Continued.

Quinnipiac Fertilizer Company, New London, Conn. : —
- Quinnipiac Phosphate.
- Quinnipiac Potato Manure.
- Quinnipiac Dry Ground Fish.
- Quinnipiac Fish and Potash.
- Quinnipiac Market-garden Manure.
- Quinnipiac Bone Meal.
- Quinnipiac Tobacco Fertilizer.
- Muriate of Potash.
- Sulphate of Potash.

Standard Fertilizer Company, Boston, Mass. : —
- Standard Fertilizer.
- Standard Superphosphate.

Sanford Winter, Brockton, Mass. : —
- Pure Ground Bone.

Forest City Wood Ash Company, London, Ont. : —
- Unleached Wood Ashes.

Benjamin Randall, East Boston, Mass. : —
- Market-garden Fertilizer.
- Standard Ground Bone.

Great Eastern Fertilizer Company, Rutland, Vt. : —
- Great Eastern General, for Grain and Grass.
- Great Eastern Vegetable, Vine and Tobacco Fertilizers.
- Great Eastern General, Oats, Buckwheat and Seeding-down Phosphate.

E. H. Smith, Northborough, Mass. : —
- Steamed Bone.

John G. Jefferds, Worcester, Mass. : —
- Jefferds' Animal Fertilizer.
- Jefferds' Fine-ground Bone.

James E. McGovern, Lawrence, Mass. : —
- West Andover Market Bone Phosphate.
- Fine-ground Bone.

Thos. Hersom & Co., New Bedford, Mass. : —
- Meat and Bone.
- Pure Fine-ground Bone.

3. *List of Dealers who have secured Certificates, etc.* — Continued.

Adams & Thomas, Springfield, Mass. : —
    Adams' Market Bone Fertilizer.

Hargrave Manufacturing Company, Fall River, Mass. : —
    Steamed Bone.

Mapes Formula and Peruvian Guano Company, New York, N. Y. : —
    The Mapes Bone Manures.
    Peruvian Guano.
    Mapes Superphosphate.
    Mapes Special Crop Manures.

L. B. Darling Fertilizer Company, Pawtucket, R. I. : —
    Darling's Animal Fertilizer.
    Extra Bone Phosphate.
    Potato and Root Crop Manure.
    Fine Bone.
    Dissolved Bone.
    Fertilizer for Lawns and Gardens.

Bowker Fertilizer Company, Boston, Mass. : —
    Stockbridge Manures.
    Hill and Drill Phosphate.
    Lawn and Garden Phosphate.
    Ammoniated Bone Fertilizer.
    Fish and Potash.
    Dry Ground Fish.
    Gloucester Fish and Potash.
    Fresh Ground Bone.
    Plain Superphosphate.
    Kainite.
    Nitrate of Soda.
    Dried Blood.
    Dissolved Bone-black.
    Muriate of Potash.
    Sulphate of Potash.
    Breck's Lawn and Garden Dressing.

Lucien Sanderson, New Haven, Conn. : —
    Formula A.
    Pulverized Bone Meal.
    Dissolved Bone-black.
    Sulphate of Potash.

3. *List of Dealers who have secured Certificates, etc.* — Concluded.

Prentiss, Brooks & Co., Holyoke, Mass. : —
  H. L. Phelps' Complete Manures.
  Dry Fish.
  Muriate of Potash.
  Nitrate of Soda.
  Dissolved Bone-black.
  H. L. Phelps' Superphosphate.
  Fish and Potash.
  Guano and Potash.
  Tankage.

The Le Page Company, Boston, Mass. : —
  Red Star Brand 203 Fertilizer.
  Red Star Brand Special Potato Manure.

John S. Reese & Co., Baltimore, Md. : —
  Bay State Fertilizer.
  New England Favorite.
  Bay State Fertilizer, G. G.
  May Flower Guano.
  Pilgrim Fertilizer.
  Great Planet, A.
  Columbus, A.
  Potato and Corn.
  Fish and Potash.
  Dry Ground Fish.

Thomas Joynt, St. Helens, Ont. : —
  Canada Hardwood Ashes.

National Fertilizer Company, Bridgeport, Conn. : —
  Chittenden's Complete Fertilizer.
  Chittenden's Fish and Potash.
  Chittenden's Universal Phosphate.
  Ground Bone.

W. J. Brightman & Co., Tiverton, R. I. : —
  Fish and Potash.
  Ground Acidulated Fish Guano.
  Ammoniated Bone Superphosphate.

4. *Analyses of Commercial Fertilizers collected during 1891, in the General Markets, by the Agent of the Massachusetts Agricultural Experiment Station.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
1	Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Worcester.
5	Mapes Manure for Corn,	Mapes Formula and Peruvian Guano Company, New York,	Northampton.
6	Mapes Manure for Tobacco,	Mapes Formula and Peruvian Guano Company, New York,	Northampton.
7	Mapes Manure for Potatoes,	Mapes Formula and Peruvian Guano Company, New York,	Northampton.
11	Stockbridge's Manure for Onions,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
12	Stockbridge's Manure for Potatoes and Vegetables,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
15	Bradley's X. L. Superphosphate,	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
16	Bradley's Potato Manure,	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
18	Adams' Market Bone Fertilizer,	Adams & Thomas, Springfield, Mass.,	Springfield.
19	Quinnipiac Phosphate,	The Quinnipiac Company, Boston, Mass.,	Northampton.
20	Quinnipiac Fish and Potash (crossed fish brand),	The Quinnipiac Company, Boston, Mass.,	Northampton.
26	Quinnipiac Dry Ground Fish,	The Quinnipiac Company, Boston, Mass.,	Hatfield.
36	Lowell Bone Fertilizer,	J. M. Butman, Chelmsford, Mass.,	Chelmsford.
37	Animal Fertilizer,	Ames Fertilizer Company, Peabody, Mass.,	West Acton.
38	Chittenden's Complete Fertilizer for Potatoes, Roots and Vegetables,	National Fertilizer Company, Bridgeport, Conn.,	West Acton.
	Bones.		
2	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Worcester.
3	Jefferds' Fine-ground Bone,	John G. Jefferds, Worcester, Mass.,	Worcester.
4	Fine-ground Bone,	Gilbert E. Holmes, Worcester, Mass.,	Worcester.
33	Bowker's Fresh Ground Bone,	Bowker Fertilizer Company, Boston, Mass.,	Concord.
40	Chittenden's Ground Bone,	National Fertilizer Company, Bridgeport, Conn.,	West Acton.
52	Ground Bone,	Edmund Hersey, Hingham, Mass.,	Hingham.
59	Steamed Bone,	E. H. Smith, Northborough, Mass.,	Amherst.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
1	Animal Fertilizer,	5.06	5.30	3.3—4.12	.50	8.29	4.25	13.04	16—18	8.79	-	7.99	7—8
5	Mapes Manure for Corn,	4.95	3.60	3.71—4.12	4.99	4.68	.83	10.50	10—12	9.67	8—10	6.53	6—7
6	Mapes Manure for Tobacco,	11.95	5.64	6.18	.78	3.13	1.96	5.87	4.5	3.91	-	10.21	10.50*
7	Mapes Manure for Potatoes,	11.37	3.56	3.71—4.12	6.78	1.13	1.43	9.34	8—10	7.91	8	7.80	6—8*
11	Stockbridge's Manure for Onions,	11.45	3.10	3—4	4.11	5.32	1.61	11.04	8—10	9.43	7—8	5.75	5—6
12	Stockbridge's Manure for Potatoes and Vegetables,	10.34	3.48	3.25—4.25	4.72	4.68	2.06	11.46	8—10	9.40	7—8	5.48	5—6
15	Bradley's X. L. Superphosphate,	14.20	2.83	2.5—3.25	7.42	2.54	1.75	11.71	11—14	9.96	9—11	2.72	2—3*
16	Bradley's Potato Manure,	13.25	4.29	2.5—3.25	4.34	5.42	2.34	12.10	8—11	9.76	6—8	4.30	5—6*
18	Adams' Market Bone Fertilizer,	10.02	4.49	2.5—3.5	.61	6.46	3.80	10.87	8—10	7.07	6—8	4.85	3—5
19	Quinnipiac Phosphate,	14.15	2.95	2.47—3.3	5.55	4.65	1.02	11.22	10—15	10.20	9—12	2.41	2—3
20	Quinnipiac Fish and Potash (crossed fish brand),	20.16	3.60	3.3—4.12	.23	2.23	6.18	8.64	5—9	2.46	4—6	4.82	4—6*
26	Quinnipiac Dry Ground Fish,	9.26	8.60	7.41—9.06	.26	3.01	4.16	7.43	7—9	3.27	-	-	-
36	Lowell Bone Fertilizer,	13.23	2.46	2—2.5	6.17	3.78	1.05	11.00	10—16.5	9.95	9—13.5	2.94	2—3.5
37	Animal Fertilizer,	16.58	3.35	3.3—4.12	3.94	5.68	.40	10.02	9—12	9.62	8—10	3.22	2.75—3.5
38	Chittenden's Complete Fertilizer for Potatoes, Roots and Vegetables,	14.76	3.42	3.3—4.12	3.40	4.82	2.72	10.94	8—10	8.22	6—8	6.98	6—8

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Mechanical Analysis.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Fine.	Fine Medium.	Medium.	Coarse Medium.
	Bones.														
2	Pure Ground Bone,	5.40	2.77	2—3	.41	14.32	12.05	26.78	25—27	14.73	-	56.92	19.79	17.32	5.97
3	Jefferds' Fine-ground Bone,	10.39	1.85	2.47—4.12	.20	13.90	11.54	25.63	25—30	14.10	-	69.59	24.99	5.42	-
4	Fine-ground Bone,	4.40	2.71	2.5—3.5	.26	12.20	12.60	25.06	22—24	12.46	-	49.00	32.86	14.29	3.85
33	Bowker's Fresh Ground Bone,	9.76	3.17	2.47—3.3	2.69	12.17	4.18	19.04	18—22	14.86	5—7	45.29	25.30	22.35	7.06
40	Chittenden's Ground Bone,	6.06	3.80	2.88—3.71	.29	5.96	14.42	20.67	20—24	6.25	-	41.24	25.19	19.19	14.38
52	Ground Bone,	4.70	3.78	3—4	.29	6.65	14.35	21.29	19—25	6.94	-	46.87	37.72	14.04	1.37
59	Steamed Bone,	6.61	4.03	3.86	.25	5.00	17.21	22.46	22.69	5.25	5.84	49.19	27.20	21.16	2.45

* Sulphate of potash, the source of potash.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
28	Bowker's Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Littleton.
35	Dow's Nitrogenous Superphosphate,	John C. Dow & Co., Boston, Mass.,	South Acton.
39	Chittenden's Ammoniated Bone Superphosphate,	National Fertilizer Company, Bridgeport, Conn.,	West Acton.
41	Original Bay State Bone Superphosphate,	J. A. Tucker & Co., Boston, Mass.,	Framingham.
42	Tobacco and Sulphur Lawn Fertilizer,	F. C. Sturtevant, Hartford, Conn.,	Concord.
46	Crocker's Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Framingham.
50	Cumberland Superphosphate,	Cumberland Bone Company, Portland, Me.,	West Acton.
60	Williams & Clark Fertilizer Company's Potato Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Springfield.
72	Church's Fish and Potash (D brand),	Joseph Church & Co., Tiverton, R. I.,	Springfield.
74	Complete Potato Manure,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
78	Great Eastern Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	Pittsfield.
79	E. Frank Coe's High-grade Ammoniated Bone Superphosphate,	E. Frank Coe, New York, N. Y.,	Lee.
88	Pilgrim Fertilizer,	John S. Reese & Co., Baltimore, Md.,	Pittsfield.
95	Pulverized Meat and Bone,	Lucien Sanderson, New Haven, Conn.,	Hadley.
104	Soluble Pacific Guano,	W. D. Stewart, Boston, Mass.,	Sunderland.
107	Bradley's High-grade Tobacco Manure,	Bradley Fertilizer Company, Boston, Mass.,	Sunderland.
109	Cleveland Potato Phosphate,	Cleveland Dryer Company, Boston, Mass.,	South Deerfield.
114	Pilgrim Fertilizer,	John S. Reese & Co., Baltimore, Md.,	Barre Plains.
115	Soluble Pacific Guano,	W. D. Stewart, Boston, Mass.,	Barre Plains.
127	Brightman & Co.'s Dry Ground Menhaden Fish Guano,	Wm. J. Brightman & Co., Tiverton, R. I.,	Fall River.
130	Meat and Bone,	Thos. Hersom & Co., New Bedford, Mass.,	New Bedford.
132	Tobacco and Sulphur Lawn Fertilizer,	F. C. Sturtevant, Hartford, Conn.,	New Bedford.
139	Whittemore's Complete Manure,	Whittemore Bros., Wayland, Mass.,	Wayland.
140	Standard Fertilizer,	Standard Fertilizer Company, Boston, Mass.,	Saxonville.
145	Church's Fish and Potash (D brand),	Joseph Church & Co., Tiverton, R. I.,	Taunton.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
28	Bowker's Hill and Drill Phosphate,	15.52	2.83	2.5—3.25	6.15	2.88	2.57	11.60	12—14	9.03	8—10	2.14	2—3
35	Dow's Nitrogenous Superphosphate,	16.48	2.34	2.06—2.88	3.97	5.17	2.32	11.46	-	9.14	8—10	3.14	3—4
39	Chittenden's Ammoniated Bone Superphosphate,	20.55	2.14	1.65—2.47	6.37	2.56	1.69	10.62	9—11	8.93	7—9	2.96	2—4
41	Original Bay State Bone Superphosphate,	19.06	2.56	2.47—2.88	.91	6.78	3.30	10.99	10—12	7.69	9—9.5	2.78	2—3
42 132	Tobacco and Sulphur Lawn Fertilizer,	17.17	1.76	1.96	-	-	-	.81	.75	-	-	8.06	7.66
46	Crocker's Ammoniated Wheat and Corn Phos.,	17.25	3.12	2—3	5.56	5.36	4.14	15.06	-	10.92	10—13	3.10	1.75—2.92*
50	Cumberland Superphosphate,	16.20	3.30	2—3	4.62	5.60	3.88	14.10	12—14	10.22	9—12	3.14	2—3
60	Williams & Clark Fertilizer Co.'s Potato Phos.,	13.68	3.24	2.47—3.30	5.42	.78	2.65	8.85	-	6.20	6—9	5.55	5—6*
72 145	Church's Fish and Potash (D brand),	25.11	4.28	3.30—4.12	.84	4.30	1.05	6.19	5—6	5.14	-	4.32	3—4
74	Complete Potato Manure,	11.52	3.40	3.30	4.44	2.38	1.24	8.06	-	6.82	5.75	11.34	10
78	Great Eastern Vegetable, Vine and Tob. Fer.,	17.00	2.10	2.06—2.88	5.94	2.21	1.93	10.08	-	8.15	8—12	6.48	6—8
79	Coe's High-grade Ammoniated Bone Sup'rph.,	15.59	2.50	2—2.5	7.68	2.50	2.20	12.38	11—13	10.18	9—12	2.08	2*
88 114	Pilgrim Fertilizer,	7.56	1.56	1—1.45	3.70	5.20	1.77	10.67	7.5—11.5	8.90	6.5—8.5	3.51	2.5—3.5
95	Pulverized Meat and Bone,	1.95	5.85	4.94—5.77	.77	8.85	7.70	17.32	18—20	9.62	-	-	-
104 115	Soluble Pacific Guano,	16.27	3.00	2.25—3	7.22	2.68	2.02	11.92	10.5—16	9.90	8.5—12	4.64	3.70—6.50
107	Bradley's High-grade Tobacco Manure,	9.06	5.46	5.77—6.59	1.43	3.04	2.05	6.52	4—5	4.47	-	9.62	10.80—12.40*
109	Cleveland Potato Phosphate,	18.31	2.37	2.05—2.85	7.19	2.18	2.09	11.46	-	9.37	8—10	3.66	3.25—4.25*
127	Brightman & Company's Dry Gr. Men. F. G.,	10.51	7.96	8.24—9.89	1.15	3.43	3.77	8.35	6.87—9.16	4.58	-	-	-
130	Meat and Bone,	4.81	4.48	4.24	.38	6.85	11.55	18.78	19.52	7.23	6.73	-	-
139	Whittemore's Complete Manure,	15.90	2.58	2.47—3.30	4.41	8.45	3.28	16.14	18—14	12.86	8—12	4.68	3—4
140	Standard Fertilizer,	17.23	2.95	2—3	7.00	4.90	1.84	13.74	10—15	11.90	8—12	3.19	2—3*

* Sulphate of potash, the source of potash.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
48	Bone Superphosphate for Vegetables,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Framingham.
54	Bowker's Bone-black,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
61	Ammoniated Bone Superphosphate (Americus Brand),	Williams & Clark Fertilizer Company, Boston, Mass.,	Springfield.
67	The H. L. Phelps Superphosphate,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
75	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
92	Dissolved Bone-black,	Lucien Sanderson, New Haven, Conn.,	Hadley.
99	Wilcox Potato Manure,	Leander Wilcox, Mystic, Conn.,	Amherst.
123	Darling's Animal Fertilizer,	Darling Fertilizer Co., Pawtucket, R. I.,	Worcester.
133	Strawberry Special,	Read Fertilizer Company, New York, N. Y.,	Dighton.
147	Fish and Potash,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
150	Randall's Market-garden Fertilizer,	Benj. Randall, East Boston, Mass.,	East Boston.
155	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Newburyport.
156	Red Star Brand Special Fertilizer for Potatoes, Cabbages, etc.,	Le Page Company, Boston, Mass.,	Boston.
162	Lister's Success Standard Fertilizer,	Lister Agricultural and Chemical Works, Newark, N. J.,	Lowell.
177	Huanillos Peruvian Guano,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Boston.
185	Fish and Potash,	Read Fertilizer Company, Syracuse, N. Y.,	Northampton.
190	Lister's Ammoniated Dissolved Bone,	Lister Agricultural and Chemical Works, Newark, N. J.,	
	Bones.		
62	Fine Pure Ground Bone,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
117	Pure Ground Bone,	Hargrave Manufacturing Company, Fall River, Mass.,	Fall River.
167	Lavery's Pure Ground Bone,	William Lavery, Amesbury, Mass.,	Amesbury.
170	West Andover Ground Bone,	James E. McGovern, Lawrence, Mass.,	Lawrence.
181	S. Winter's Pure Ground Bone,	Sanford Winter, Brockton, Mass.,	Brockton.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
48 155	Bone Superphosphate for Vegetables,	11.64	5.52	5—6	3.42	4.11	1.30	8.83	-	7.53	6—7	6.72	6—8*
54	Bowker's Bone-black,	18.64	-	-	13.43	2.38	.59	16.40	-	15.81	15—18	-	-
61	Americus Brand Ammon. Bone Superphosphate,	14.42	2.68	2.47—3.30	7.77	1.75	2.46	11.98	-	9.52	9—11	1.90	2—3*
67	The H. L. Phelps Superphosphate,	15.72	2.62	2.47—3.30	9.11	-	.75	9.86	10—12	9.11	8—10	3.25	3—4
75	A. A. Ammoniated Superphosphate,	8.01	3.86	2.47—3.30	8.12	.27	1.10	9.49	-	8.39	10—12	2.03	2—3
92	Dissolved Bone-black,	17.30	-	-	15.94	.51	.46	16.91	-	16.45	16—18	-	-
99	Wilcox Potato Manure,	20.61	3.82	3.25—4.25	5.23	1.77	.52	7.52	8—9	7.00	7—8	6.10	6—7
123	Darling's Animal Fertilizer,	15.82	3.40	3.30—4.94	3.39	3.04	4.89	11.32	10—12	6.43	-	4.28	4—6
133	Strawberry Special,	17.50	3.62	3.30—4.94	3.61	1.49	2.10	7.20	6—8	5.10	5—6	6.80	6—8*
147	Fish and Potash,	14.04	4.00	2.47—4.11	6.79	2.70	1.54	11.03	7—10	9.49	6.5—8	4.64	3—5
150	Randall's Market-garden Fertilizer,	22.40	3.92	1.65—2.88	7.06	3.83	.82	11.71	10—16	10.89	8—11	2.09	2—4
156	Red Star Brand Special Fertilizer for Potatoes, etc.,	16.05	3.98	3—4	5.26	2.39	1.45	9.10	8—10	7.65	6—8	5.80	5—6*
162	Lister's Success Standard Fertilizer,	21.86	1.89	.91—1.65	8.32	2.11	1.07	11.50	10.5—12	10.43	-	1.53	1.5—2*
177	Huanillos Peruvian Guano,	14.63	1.18	1.58	.18	4.65	21.57	26.40	27.56	4.83	-	.25	.29
185	Fish and Potash,	19.31	2.60	2.47—3.30	3.36	.89	1.38	5.63	5—6	4.25	4—5	4.48	4—5*
190	Lister's Ammoniated Dissolved Bone,	11.89	2.48	1.81—2.06	6.67	2.18	5.35	14.20	11—13	8.85	9—10	1.69	2—3*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Mechanical Analysis. Fine.	Fine Medium.	Medium.	Coarse Medium.
	Bones.														
62	Fine Pure Ground Bone,	10.03	3.34	3.30—3.91	-	2.37	21.62	23.97	22—26	2.35	-	.03	10.79	82.40	6.78
117	Pure Ground Bone,	6.68	2.88	2.50—2.80	.67	13.75	10.69	25.13	25—27	14.44	-	36.37	22.23	18.60	22.80
167	Lavery's Pure Ground Bone,	9.25	2.52	-	.18	9.16	5.97	15.31	-	9.34	-	47.05	32.38	18.51	2.06
170	West Andover Ground Bone,	10.24	2.02	-	-	12.76	10.59	23.35	-	12.76	-	63.20	26.60	8.34	1.86
181	S. Winter's Pure Ground Bone,	8.07	2.56	3.16	.45	12.26	13.29	26.00	23.60	12.71	11.28	53.72	26.35	15.73	4.20

* Sulphate of potash, the source of potash.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
66	Fish and Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
69	Tankage,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
77	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Pittsfield.
84	Extra Fine-ground Bone with Potash (circle brand),	Bradley Fertilizer Company, Boston, Mass.,	Pittsfield.
89	Reese's May Flower Guano,	John S. Reese & Co , Baltimore, Md.,	Pittsfield.
93	Blood, Meat and Bone,	Lucien Sanderson, New Haven, Conn.,	Hadley.
102	Wilcox's Dry Ground Fish Guano,	Leander Wilcox, Mystic, Conn.,	Amherst.
112	Blue Brand Excelsior Guano,	E. Frank Coe, New York, N. Y.,	South Deerfield.
122	Reese's May Flower,	John S. Reese & Co., Baltimore, Md.,	Barre Plains.
124	Complete Grass Manure,	H. J. Baker & Bro , New York, N. Y.,	Fall River.
128	Fish Pomace,	W. J. Brightman & Co., Tiverton, R. I.,	Taunton.
138	Quinnipiac Market Garden Fertilizer,	The Quinnipiac Company, Boston, Mass.,	Fall River.
148	Dry Ground Fish,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
166	Bowker's Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Woburn.
172	Dow's Ground Bone Fertilizer,	John C. Dow & Co., Boston, Mass.,	Boston.
175	Standard Guano,	Standard Fertilizer Company, Boston, Mass.,	Boston.
186	B. D. Sea Fowl Guano,	Bradley Fertilizer Company, Boston, Mass.,	Greenfield.
	Bones.		
80	Pure Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lee.
86	Quinnipiac Pure Bone Meal,	The Quinnipiac Company, Boston, Mass.,	Williamstown.
91	Quinnipiac Pure Bone Meal,	The Quinnipiac Company, Boston, Mass.,	Springfield.
131	Pure Fine-ground Bone,	Thos. Hersom & Co., New Bedford, Mass.,	New Bedford.
151	Standard Ground Bone,	Benj. Randall, East Boston, Mass.,	East Boston.
154	Pure Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Newburyport.
161	Lister's Celebrated Ground Bone,	Lister Agricultural and Chemical Works, Newark, N. J.,	Lowell.
192	Dow's Ground Bone,	John C. Dow & Co., Boston, Mass.,	

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.		Mechanical Analysis.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.	Guaranteed.	Fine.	Fine Medium.	Medium.	Coarse Medium.
								Found.	Guaranteed.	Found.	Guaranteed.						
	Compound Fertilizers.																
66	Fish and Potash,	9.91	4.38	3.30—4.12	1.46	2.15	1.97	5.58	5—6	3.61	-	4.80	4—5				
69	Tankage (Prentiss, Brooks & Co.),	5.14	6.32	5.77	-	7.04	3.07	10.11	10—11	7.04	-	-	-				
77	New Rival Ammoniated Superphosphate,	13.81	1.39	1.2—2.05	3.40	6.20	2.83	12.43	-	9.60	10—12	2.27	1.6—2.7*				
84	Bone and Potash (Bradley),	10.86	2.34	1.85—2.68	.99	4.74	6.83	12.56	8—12	5.73	-	2.22	2—3				
89	Reese's May Flower Guano,	15.46	2.10	1.65—2.06	2.97	7.70	.86	11.53	9.5—12.5	10.67	8—9	1.93	2—2.5				
93	Blood, Meat and Bone,	6.00	6.46	5.77—7.41	.26	5.30	5.40	10.96	10—12	5.56	-	-	-				
102	Wilcox's Dry Ground Fish Guano,	8.32	8.76	8—10	.77	4.21	3.12	8.10	-	4.98	4—6	-	-				
112	Blue Brand Excelsior Guano,	10.06	6.08	6—7	6.40	1.82	2.05	10.27	-	8.22	7—10	3.56	3*				
122	Reese's May Flower,	9.25	2.00	1.8—2.05	3.08	6.95	.93	10.96	10—13	10.03	8.5—10	2.49	2.25—3				
124	Baker's Complete Grass Manure,	13.26	3.24	3.71	6.05	.41	.26	6.72	5	6.46	-	8.95	7.5				
128	Brightman's Fish Pomace,	38.09	4.87	-	.19	.64	2.85	3.68	-	.83	-	-	-				
138	Quinnipiac Market Garden Fertilizer,	12.33	3.44	3.30—4.12	7.45	1.94	1.37	10.76	9—13	9.39	8—11	7.14	7—8*				
148	Reese's Dry Ground Fish,	7.38	8.72	8.65	.41	2.40	4.55	7.36	-	2.81	-	-	-				
166	Bowker's Lawn and Garden Dressing,	12.87	4.02	4—5	5.88	2.23	2.02	10.13	6—8	8.11	5—6	6.88	5—6*				
172	Dow's Ground Bone Fertilizer,	3.80	2.46	2.06—2.47	.84	5.97	14.35	21.16	18—22	6.81	-	3.53	3—4				
175	Standard Guano,	16.89	2.29	1—2	7.06	3.19	1.28	11.53	10—15	10.25	8—12	2.08	2—3*				
186	B. D. Sea Fowl Guano,	15.75	2.58	2.5—3.25	6.63	3.28	2.35	12.26	11—14	9.91	9—11	2.03	2—3*				
	Bones.																
80 154	Crocker's Pure Ground Bone,	7.51	3.74	2.9—3.7	.23	4.94	17.35	22.52	25	5.17	-			23.17	31.76	26.06	19.01
86 91	Quinnipiac Pure Bone Meal,	11.93	2.49	2.47—4.12	.10	6.08	15.38	21.56	20—25	6.18	-			62.67	35.32	2.01	-
131	Pure Fine-ground Bone,	7.59	2.00	2.8	.50	8.91	19.80	29.21	29.42	9.41	13.62			62.59	16.67	17.40	3.34
151	Standard Ground Bone,	11.89	2.64	2—3	3.04	5.94	5.26	14.24	14—16	8.98	5—7			35.18	40.25	30.32	4.25
161	Lister's Celebrated Ground Bone,	8.05	2.90	2.7—2.9	.32	4.95	6.88	12.15	12—14	5.27	-			38.75	29.10	17.15	15.00
192	Dow's Ground Bone,	5.80	1.81	1.65—2.47	.16	8.21	18.06	26.43	24—26	8.37	-			64.17	35.83	-	-

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* Sulphate of potash, the source of potash.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
13	Stockbridge's Manure for Top-dressing,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
17	Hampden Lawn Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
32	Stockbridge's Manure for Top-dressing,	Bowker Fertilizer Company, Boston, Mass.,	Littleton.
34	Stockbridge's Manure for Strawberries and Small Fruits,	Bowker Fertilizer Company, Boston, Mass.,	Concord.
44	English Lawn Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Lowell.
47	Crocker's Special Potato Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Framingham.
49	Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	South Acton.
63	The H. L. Phelps' Complete Manure for Grass,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
71	Guano and Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
81	Crocker's Special Potato Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
82	Quinnipiac Potato Manure,	The Quinnipiac Company, Boston, Mass.,	Williamstown.
83	Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
87	Stockbridge's Manure for Seeding Down,	Bowker Fertilizer Company, Boston, Mass.,	Pittsfield.
98	Quinnipiac Grass Fertilizer,	The Quinnipiac Company, Boston, Mass.,	Williamstown.
100	Wilcox's High-grade Fish and Potash,	Leander Wilcox, Mystic, Conn.,	Amherst.
101	Wilcox's Ammoniated Bone Phosphate,	Leander Wilcox, Mystic, Conn.,	Amherst.
105	Bradley's Complete Manure for Top-dressing,	Bradley Fertilizer Company, Boston, Mass.,	Sunderland.
106	Bradley's Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Company, Boston, Mass.,	Sunderland.
110	Cleveland Superphosphate,	Cleveland Dryer Company, Boston, Mass.,	South Deerfield.
111	Red Brand Excelsior Guano,	E Frank Coe, New York, N. Y.,	South Deerfield.
113	Bay State Fertilizer G. G.,	John S. Reese & Co., Baltimore, Md.,	Barre Plains.
116	Concentrated Potato and Corn Manure,	John S. Reese & Co., Baltimore, Md.,	Barre Plains.
118	Church's Special Fertilizer,	Joseph Church & Co., Tiverton, R. I.,	Dighton.
120	Darling's Fertilizer for Gardens and Lawns,	Darling Fertilizer Company, Pawtucket, R. I.,	Worcester.
129	Church's Pure Dry Fish,	Joseph Church & Co., Tiverton, R. I ,	Dighton.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
13 32	Stockbridge's Manure for Top-dressing,	5.76	5.05	5—6	3.20	.83	6.33	10.36	6—7	4.03	3—4	6.51	5—6
17	Hampden Lawn Dressing,	9.40	4.54	3.30—4.12	2.53	2.77	1.33	6.63	7—9	5.30	6—8	2.23	2—3
34	Stockbridge's Manure for Strawberries and Small Fruits,	10.47	3.08	2.50—3.25	7.01	1.28	2.51	10.80	7—9	8.29	6—7	3.18	4.32—5.40*
44	English Lawn Fertilizer,	8.94	5.10	4.95—5.78	2.99	2.88	1.09	6.96	6—8	5.87	5—7	3.01	2.50—3.50
47 81	Crocker's Special Potato Manure,	11.58	3.36	3.70—4.50	5.44	1.23	2.00	8.67	9—11	6.67	8—9	6.97	5—6*
49 83	Ammoniated Bone Superphosphate,	11.45	2.60	2.90—3.70	4.96	3.23	3.91	12.10	10—12	8.19	10—13	1.76	1—2*
63	The H. L. Phelps' Complete Manure for Grass,	11.62	4.70	4.12—4.94	4.91	1.73	.47	7.11	6—8	6.64	3—4	7.76	8—10
71	Guano and Potash,	11.65	3.64	3.30—4.12	1.07	3.34	2.97	7.38	5—6	4.41	-	5.03	5—7
82	Quinnipiac Potato Manure,	14.52	3.10	2.47—3.30	2.88	3.09	3.71	9.68	7—11	5.97	6—9	4.90	5—6*
87	Stockbridge's Manure for Seeding Down,	11.95	2.36	2.47—3.30	5.27	5.27	2.30	12.84	12—14	10.54	6—8	8.38	5.05—6.32
98	Quinnipiac Grass Fertilizer,	12.91	3.58	3.30—4.12	4.25	1.80	2.69	8.74	7—10	6.05	6—8	4.81	5—7*
100	Wilcox's High-grade Fish and Potash,	22.50	4.00	3.25—4.25	2.65	1.89	2.05	6.59	6—7	4.54	5—6	4.21	4—5
101	Wilcox's Ammoniated Bone Phosphate,	21.50	4.00	3.25—4.25	3.63	2.05	2.10	7.78	7—8	5.68	6—7	5.07	5—6
105	Bradley's Complete Manure for Top-dressing,	8.21	5.16	6—7	1.92	2.78	2.02	6.72	6—9	4.70	5—7	2.90	2.50—3.50*
106	Bradley's Complete Manure for Potatoes and Vegetables,	11.36	4.08	3.73—4.52	4.30	5.06	2.56	11.92	9—13	9.36	8—11	4.72	6—7
110	Cleveland Superphosphate,	14.62	2.80	2.05—2.85	5.82	2.88	2.94	11.65	11—14	8.70	9—11	2.26	2—3*
111	Red Brand Excelsior Guano,	12.33	2.96	3.50—4	7.00	.18	3.28	10.46	10—14	7.18	9—12	5.08	6*
113	Bay State Fertilizer G. G.,	19.33	1.92	1.80—2.50	2.61	8.16	.77	11.54	10—13	10.77	8.5—10	2.34	2.25—3
116	Concentrated Potato and Corn Manure,	15.61	3.28	2.97—3.80	3.83	4.63	.42	8.88	7—10	8.46	6—8	7.61	7.50—9.50
118	Church's Special Fertilizer,	13.99	5.16	4.94—5.77	4.35	2.77	1.96	9.08	12—13	7.12	-	6.72	6—7
120	Darling's Fertilizer for Gardens and Lawns,	10.53	5.08	4.94—6.59	1.69	6.53	3.89	12.11	10—12	8.22	-	4.95	5—6
129	Church's Pure Dry Fish,	10.10	9.35	8.24—9.89	.10	4.06	3.16	7.32	6.87—11.45	4.16	-	-	-

* Sulphate of potash, the source of potash.

4. *Analyses of Commercial Fertilizers, etc.* — Continued.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
29	Stockbridge's Manure for Corn, Grain and Fodder Corn,	Bowker Fertilizer Company, Boston, Mass.,	Littleton.
103	Gold Brand Excelsior Guano,	E. Frank Coe, New York, N. Y.,	Sunderland.
143	Bradley's Dry Ground Fish Guano,	Bradley Fertilizer Company, Boston, Mass.,	Taunton.
144	Bradley's Fish and Potash,	Bradley Fertilizer Company, Boston, Mass.,	Taunton.
146	New England Favorite,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
149	Columbus A. Manure,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
153	The Lawrence Fertilizer,	A. Lee & Co., Lawrence, Mass.,	Lawrence.
163	Williams & Clark Company's Royal Bone Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
164	Williams & Clark Company's Prolific Crop Producer,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
171	Breck's Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass., Licensees,	Boston.
173	Mayo's Superphosphate,	Clarence E. Mayo & Co , Boston, Mass.,	Woburn.
174	N. Ward Company's High-grade Animal Fertilizer,	The N. Ward Company, Boston, Mass.,	Boston.
182	Read's Standard Phosphate,	Read Fertilizer Company, Syracuse, N. Y.,	Greenfield.
184	High-grade Farmers' Friend,	Read Fertilizer Company, Syracuse, N. Y.,	Northampton.
	Chemicals.		
21	Dissolved Bone-black,	Quinnipiac Fertilizer Company, Boston, Mass., Licensees,	Northampton.
23	Muriate of Potash,	Quinnipiac Fertilizer Company, Boston, Mass., Licensees,	Northampton.
55	High-grade Sulphate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
57	Sulphate of Ammonia,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
58	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
65	Dissolved Bone-black,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
70	Muriate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
94	Sulphate of Potash,	Lucien Sanderson, New Haven, Conn.,	Hadley.
96	Muriate of Potash,	Lucien Sanderson, New Haven, Conn.,	Hadley.
	Wood Ashes.		
14	Canada Wood Ashes,	Forest City Wood Ash Company, London, Ontario, Canada,	South Deerfield.
51	Canada Wood Ashes,	Wm. E. Fyfe & Co., Clinton, Mass., Licensees,	Concord.
180	Unleached Canada Wood Ashes,	Monroe, Judson & Stroup, Oswego, N. Y.,	N. Amherst City.
189	Canada Hard-wood Ashes,	Thomas Joynt, St. Helen's, Ontario, Canada,	Northampton.

4. *Analyses of Commercial Fertilizers, etc.* — Concluded.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
29	Stockbridge's Manure for Corn, Grain and Fodder Corn,	12.86	3.30	3.25—4.25	5.63	2.97	2.61	11.21	9—11	8.60	8—9	4.83	4.42—5.69
103	Gold Brand Excelsior Guano,	10.62	2.86	2.5—3	5.88	5.56	2.25	13.69	–	11.44	8—11	5.03	6—8*
143	Bradley's Dry Ground Fish Guano,	9.08	8.54	8.24—9.89	.58	3.42	4.80	8.80	6—8	4.00	–	–	–
144	Bradley's Fish and Potash,	19.51	3.20	2.48—3.50	3.79	2.91	1.82	8.52	7.5—9.5	6.70	6—8	2.35	2—3*
146	New England Favorite,	18.45	3.30	2.47—3.30	3.07	6.89	.79	10.75	10—14	9.96	9—12	2.62	2—3
149	Columbus A. Manure,	14.65	3.63	3.29—4.11	3.33	3.68	1.05	8.06	8—11	7.01	7—9	9.40	9.5—11
153	The Lawrence Fertilizer,	12.96	2.71	2.06—2.88	6.12	4.37	1.84	12.33	10—12	10.49	–	2.82	2—3
163	Williams & Clark Co.'s Royal Bone Phosphate,	17.18	1.58	1.03—1.65	3.43	3.00	3.15	9.58	8—11	6.43	7—9	2.13	2—3*
164	Williams & Clark Co.'s Prolific Crop Producer,	15.70	1.96	.82—1.65	4.95	3.33	2.10	10.38	7—11	8.28	6—9	1.65	1—2*
171	Breck's Lawn and Garden Dressing,	9.21	4.02	4.12—4.94	6.01	1.73	5.03	12.77	–	7.74	5—6	4.95	5—6
173	Mayo's Superphosphate,	13.67	2.84	2.05—2.85	6.65	3.43	2.61	12.69	10—14	10.08	9—11	2.82	2.5—3.5
174	N. Ward Co.'s High-grade Animal Fertilizer,	6.80	3.55	2.88—3.70	6.18	6.34	.70	13.22	–	12.52	12—14	4.41	4—5
182	Read's Standard Phosphate,	15.62	1.48	.82—1.65	7.01	1.73	1.15	9.89	10—12	8.74	8—10	3.08	4—6*
184	High-grade Farmers' Friend,	11.96	3.45	3.30—4.12	3.68	2.18	3.02	8.88	–	5.86	5—6	9.46	10—11
	Chemicals.												
21	Dissolved Bone-black,	18.82	–	–	12.84	1.81	.38	15.03	–	14.65	15—18	–	–
23	Muriate of Potash,	1.13	–	–	–	–	–	–	–	–	–	49.00	50.54—53.70
55	High-grade Sulphate of Potash,	1.55	–	–	–	–	–	–	–	–	–	48.32	51.88
57	Sulphate of Ammonia,	2.53	19.98	19.77—20.57	–	–	–	–	–	–	–	–	–
58	Nitrate of Soda,	1.81	15.76	15.65—16.14	–	–	–	–	–	–	–	–	–
65	Dissolved Bone-black,	17.73	–	–	16.14	.27	.14	16.45	–	16.41	17.50	–	–
70	Muriate of Potash,	1.35	–	–	–	–	–	–	–	–	–	51.72	53.70
94	Sulphate of Potash,	3.77	–	–	–	–	–	–	–	–	–	26.52	27.02—29.72
96	Muriate of Potash,	1.33	–	–	–	–	–	–	–	–	–	50.64	50.54—53.70
	Wood Ashes.												
14	Canada Wood Ashes,	11.15	–	–	–	–	–	1.65	1.5—2.5	–	–	5.37	4.5—8
51	Canada Wood Ashes,	4.70	–	–	–	–	–	1.02	1—3	–	–	7.00	5—8
180	Unleached Canada Wood Ashes,	24.69	–	–	–	–	–	1.56	1—2.5	–	–	4.48	4.5—7
189	Canada Hard-wood Ashes,	16.52	–	–	–	–	–	1.57	–	–	–	4.64	5—7

* Sulphate of potash, the source of potash.

Methods of Fertilizer Analysis.

Preparation of Sample. — The entire available sample is spread upon a smooth, hard surface, and intimately mixed without grinding, all lumps being broken up with a spatula. Unnecessary loss or gain of moisture is to be avoided. *Moisture:* dry 2 grams in the air-bath at 100 to 110° C. to constant weight.

1. Total Phosphoric Acid. — Weigh out 2 grams in a platinum crucible, and destroy the organic matter by carefully burning in a muffle. Weigh when cool, to determine the "organic and volatile matter." Digest the crucible and contents with dilute hydrochloric acid, until the solution of the latter is complete. Filter, and evaporate the filtrate to complete dryness. The "insoluble matter" on the filter is burned and weighed. The residue left from the evaporation is taken up with dilute nitric acid, if the molybdic method is to be followed, but with hydrochloric acid if method (2) is preferred. The solution after filtering is made up to a volume of 200 cubic centimetres with distilled water.

(1) The molybdic method: 25 cubic centimetres of the solution are digested in a water-bath at 65° C. from one to two hours, with an excess of molybdic solution. The precipitate is brought upon a filter, and washed with water containing a little molybdic solution. It is then dissolved in ammonia water, the solution nearly neutralized with hydrochloric acid, and magnesia mixture added slowly, with constant stirring. The precipitate is allowed to stand at least three hours, when it is filtered through a Gooch crucible, washed with dilute ammonia, ignited and weighed.

(2) The following method is occasionally employed when phosphates of iron and alumina are present in small quantities only: To 50 cubic centimetres of the hydrochloric acid solution add ammonia in slight excess. After standing a few minutes, acidify with acetic acid, and filter off the phosphates of iron and alumina, washing carefully with water. To the filtrate add sufficient oxalate of ammonia to precipitate all the lime; digest for several hours at a temperature below boiling, and filter through double filters which have previously been washed with oxalate of ammonia, washing

thoroughly with water. Dissolve the phosphates of iron and alumina on the filter with warm dilute hydrochloric acid, and wash into a beaker containing a small quantity of powdered tartaric acid. When the latter has gone into solution, mix with the filtrate from the oxalate of ammonia. The phosphoric acid is precipitated with magnesia mixture, and treated as in (1).

Soluble phosphoric acid: Weigh out 2 grams into a beaker, cover with 10 to 15 cubic centimetres of water, and allow it to stand for fifteen minutes, stirring three times at equal intervals. Decant the solution through a filter into a graduated cylinder. Add another like quantity of water, and let it stand fifteen minutes more, stirring as before. Filter the solution into the cylinder, and wash the residue on the filter until the filtrate amounts to 200 cubic centimetres. The phosphoric acid is determined in an aliquot part of the solution as under total phosphoric acid.

Insoluble phosphoric acid: Add 100 cubic centimeters of neutral ammonia citrate (sp. gr. 1.09) to the beaker in which the digestion with water has been made. Put in a water-bath and heat to 65° C. Drop in the filter containing the residue from the above operation, and digest for thirty minutes, stirring every five minutes. Filter and wash thoroughly, using the suction pump. Dry, and burn. The ash is then treated as under total phosphoric acid.

Reverted phosphoric acid: The sum of the soluble and insoluble substracted from the total gives the reverted or citrate-soluble phosphoric acid.

Reagents: The reagents used in the estimation of phosphoric acid are prepared according to directions given in the "Proceedings of the Association of Official Agricultural Chemists," 1890 (pages 228 and 229).

For ammonium citrate, 370 grams of citric acid are dissolved in 1,500 cubic centimetres of water, nearly neutralized with crushed carbonate of ammonia, heated to expel carbonic acid, exactly neutralized with ammonia, and brought to a specific gravity of 1.09.

The molybdic solution is prepared by dissolving 100 grams of molybdic acid in 417 cubic centimetres of ammonia of specific gravity .96. Pour this solution into 1,250 cubic centimetres of nitric acid of specific gravity 1.20, and set in a warm place for several days, or until a portion heated to 40° C. deposits no yellow precipitate.

The magnesia mixture is prepared by dissolving 110 grams of crystallized magnesium chloride and 280 grams of ammonium chloride in 700 cubic centimetres of ammonia of specific gravity .96, and bringing to a volume of two liters.

2. *Methods of Determining Nitrogen.* — The Kjeldahl and soda-lime methods recommended by the Association of Official Agricultural Chemists, in their "Proceedings." 1890, pages 190 and 191, are employed, with occasional control analyses by the absolute cupric oxide mode.

3. *Method for Determining Potash.* — Weigh out two grams of the material in a platinum crucible, and char thoroughly at a temperature just below red heat. Digest for several hours with very dilute hydrochloric acid, on the water-bath. Filter into a graduated cylinder, and make up to 200 cubic centimetres. Take 50 cubic centimetres for each test. Warm, and add in small quantities at a time, an excess of barium hydrate. Digest for one or two hours at a temperature of 70° to 90° C., filter, washing carefully, and add to the filtrate a few drops of ammonium hydrate, and enough ammonium carbonate to precipitate the excess of barium hydrate. Filter, and bring the filtrate to dryness on the water-bath in a platinum dish. Heat carefully in the covered platinum dish at a temperature just below red heat, until compounds of ammonia cease to come off. Take up the residue in water, filtering if necessary, and add an excess of platinum tetrachloride. Evaporate to dryness on the water-bath, add a small quantity of 80 per cent. alcohol, and allow it to stand for a few hours. Filter through a Gooch crucible, washing with alcohol, dry, and weigh; or filter through paper, wash as before, dry, and brush the potassium platinic chloride upon a weighed watch glass, with a camel's-hair brush, and weigh. If very impure, the double salt is washed with the strong solution of ammonium chloride, saturated with potassium platinic chloride, as recommended in the "Proceedings of the Association of Official Agricultural Chemists," 1890, page 210.

5. *Analyses of Commercial Fertilizers and Manurial Substances sent on for Examination.*

Wood Ashes.

[I., Canada wood ashes, sent on from Stow, Mass ; II , Home-made ashes, sent on from Stow, Mass.; III. and IV., sent on from North Amherst, Mass.; V., sent on from North Hatfield, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C , ...	14.88	0.25	29.49	30.69	8.68
Calcium oxide, ...	33.42	37.16	28.79	24.75	33.19
Magnesium oxide, ...	2.89	6.31	3.74	2.04	4.21
Ferric oxide, ...	1.03	2.26	0.84	0.97	1.03
Potassium oxide, ...	6.17	6.58	2.32	2.78	6.58
Phosphoric acid, ...	2.19	5.58	1.58	1.84	2.01
Insoluble matter (before calcination),	13.67	27.45	11.72	16.66	14.66
Insoluble matter (after calcination),	11.07	22.93	10.37	13.08	12.21

Wood Ashes.

[I., sent on from Lawrence, Mass ; II , sent on from Hadley, Mass ; III., sent on from Hudson, Mass.; IV., sent on from Clifton, Mass]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C., ...	8.71	13.18	18.00	15.94
Calcium oxide, ...	36.95	34.06	33.25	31.65
Magnesium oxide, ...	2.90	2.88	1.84	2.59
Ferric oxide, ...	0.07	1.32	1.42	1.62
Potassium oxide, ...	5.77	4.56	4.51	4.71
Phosphoric acid, ...	1.38	1.66	1.18	1.43
Insoluble matter (before calcination),	13.15	13.60	12.99	13.38
Insoluble matter (after calcination), .	11.88	11.16	10.84	10.62

5. *Analyses, etc.* — Continued.

Wood Ashes.

[I., from North Amherst, Mass.; II, from North Hadley, Mass.; III, Railroad tie ashes, from Winchester, Mass; IV., from Hudson, Mass.; V, from North Amherst, Mass.; VI., from Lawrence, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., . . .	11.47	3.46	4.70	18.10	10.38	16.12
Calcium oxide, . . .	37.51	35.76	2.51	31.75	23.84	30.38
Magnesium oxide, . .	3.20	4.32	1.22	2.59	3.05	2.64
Ferric oxide, . . .	0.24	0.55	4.23	0.77	5.89	1.32
Potassium oxide, . . .	4.22	4.21	0.92	3.32	2.93	3.94
Phosphoric acid, . . .	1.40	2.01	0.56	1.34	1.14	1.52
Insoluble matter (before calcination), ...	18.84	17.19	84.51	12.53	35.27	17.52
Insoluble matter (after calcination), ...	16.11	14.85	80.20	10.53	33.73	13.10

Wood Ashes.

[I., sent on from East Whately, Mass; II., III., IV. and V., sent on from Concord, Mass]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., ...	10.52	3.60	21.40	13.75	15.14
Calcium oxide, ...	37.07	33.78	29.65	33.39	–
Magnesium oxide, ...	3.46	6.66	4.16	3.38	–
Ferric oxide, ...	0.72	1.51	0.78	0.49	–
Potassium oxide, ...	6.48	9.62	5.22	7.24	5.75
Phosphoric acid, ...	1.43	4.25	1.54	1.53	1.69
Insoluble matter (before calcination),	9.70	9.98	9.87	10.96	13.44
Insoluble matter (after calcination),	7.06	5.52	7.96	9.19	11.40

All above-stated samples of unleached wood ashes are represented as Canada wood ashes, except No. II., which is a home-made wood ash.

5. *Analyses, etc.* — Continued.

Wood Ashes.

[I., sent on from Concord, Mass.; II., sent on from Beverly, Mass.; III., sent on from Sunderland, Mass.; IV., sent on from North Amherst, Mass.; V., sent on from Sunderland, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	15.50	11.78	15.69	9.52	17.48
Calcium oxide,	30.16	29.12	31.59	25.12	32.23
Magnesium oxide,	3.28	4.53	3.30	4.67	3.07
Ferric oxide,	0.99	1.14	0.40	1.49	0.67
Potassium oxide,	6.76	4.77	6.99	3.83	5.04
Phosphoric acid,	2.13	1.83	1.39	1.40	1.17
Insoluble matter (before calcination),	12.04	15.16	11.10	28.38	11.72
Insoluble matter (after calcination),	11.68	11.48	10.26	22.05	10.74

Wood Ashes.

[I., sent on from Rock Bottom, Mass.; II., sent on from South Framingham, Mass.; III., sent on from Berlin, Mass.; IV., sent on from Amesbury, Mass.; V., sent on from Beverly, Mass.; VI., sent on from Bolton, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	18.00	20.08	2.10	9.43	10.22	11.50
Calcium oxide,	34.40	32.16	36.00	32.52	38.98	35.66
Magnesium oxide,	2.90	3.28	3.30	2.14	3.39	4.45
Ferric oxide,	–	0.69	–	–	–	–
Potassium oxide,	4.52	4.65	5.27	4.90	6.28	4.57
Phosphoric acid,	1.46	2.70	1.62	1.84	1.42	1.56
Insoluble matter (before calcination),	12.39	9.67	19.47	20.52	9.51	16.58
Insoluble matter (after calcination),	11.44	8.12	17.78	18.30	8.54	14.83

All above-stated samples of unleached wood ashes are represented as Canada wood ashes. Samples I., II., IV. and VI. contain less potash than the average of Canada wood ash usually sold in our markets.

5. *Analyses, etc.* — Continued.

Wood Ashes.

[I., sent on from Framingham, Mass.; II. and III., sent on from South Deerfield, Mass.; IV., sent on from Essex, Mass.; V. and VI., sent on from Sudbury, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	19.73	7.26	20.65	0.64	16.64	24.26
Calcium oxide,	31.49	37.07	29.65	40.49	–	–
Magnesium oxide,	2.85	2.90	2.70	3.07	–	–
Ferric oxide,	1.24	1.02	1.89	–	–	–
Potassium oxide,	4.94	4.34	4.62	6.42	4.24	4.71
Phosphoric acid,	1.57	1.48	1.46	1.57	1.34	2.66
Insoluble matter (before calcination),	12.57	14.45	10.10	12.03	18.08	23.92
Insoluble matter (after calcination),	10.29	12.48	8.13	9.10	14.84	19.92

Wood Ashes.

[I., sent on from Amherst, Mass.; II., sent on from Holden, Mass; III. and IV., sent on from Concord, Mass.; V., sent on from Rock Bottom, Mass.; VI., sent on from Stow, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	12.34	19.34	17.98	16.65	11.62	13.27
Calcium oxide,	33.08	30.27	28.86	30.36	35.63	34.74
Magnesium oxide,	2.85	3.98	3.12	3.10	2.97	3.04
Ferric oxide,	0.79	0.86	0.09	1.44	0.86	0.66
Potassium oxide,	5.60	5.11	6.81	6.10	6.40	6.32
Phosphoric acid,	1.93	3.53	1.66	1.54	1.60	1.57
Insoluble matter (before calcination),	15.45	10.86	17.22	13.00	10.93	10.02
Insoluble matter (after calcination),	11.19	9.37	14.66	11.32	9.02	8.44

5. *Analyses, etc.* — Continued.

Cotton-seed-hull Ashes.

[I., sent on from Sunderland, Mass.; II. and III., sent on from North Hadley, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	7.77	6.30	4.58
Calcium oxide,	8.02	–	–
Magnesium oxide,	12.57	–	–
Potassium oxide,	30.00	16.48	9.91
Phosphoric acid,	13.19	6.58	4.41
Insoluble matter (before calcination),	12.52	41.94	57.40
Insoluble matter (after calcination),	9.40	29.65	34.28

Sample II. and in particular Sample III. are of an exceptional inferior quality. Cotton-seed-hull ashes and cotton-seed meal sold for manurial purposes ought to be bought on a guaranteed composition. Both articles are liable to a serious fluctuation in composition. All articles sold for manurial purposes, at ten dollars or more per ton, are subject to our laws for the regulation of the trade in commercial fertilizers.

Cotton-hull Ashes.

[I., sent on from North Hadley, Mass.; II., sent on from Feeding Hills, Mass.; III., sent on from Sunderland, Mass.*]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	11.79	6.30	4.41
Calcium oxide,	8.37	13.94	4.91
Magnesium oxide,	10.27	2.85	5.57
Ferric and aluminic oxides,	1.50	2.49	4.35
Potassium oxide,	26.26	26.98	16.63
Phosphoric acid,	12.06	8.40	7.21
Insoluble matter (before calcination),	15.37	13.23	47.47
Insoluble matter (after calcination),	11.94	11.19	40.02

* Cotton-hull and wood ashes mixed.

5. *Analyses, etc.* — Continued.

Cotton-hull Ashes.

[Three samples, sent on from Hatfield, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	14.18	13.65	14.22
Calcium oxide,	10.26	15.12	15.25
Magnesium oxide,	10.28	6.37	6.02
Ferric oxide,	1.88	1.51	1.08
Potassium oxide,	20.56	27.06	26.91
Phosphoric acid,	9.13	8.07	13.48
Insoluble matter (before calcination),	12.64	10.14	9.87
Insoluble matter (after calcination),	11.48	8.10	7.24

Cotton-seed Meal for Fertilizer.

[I. and II., sent on from Hatfield, Mass.; III., sent on from Amherst, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	7.98	9.84	7.28
Ash,	–	–	7.14
Phosphoric acid,	3.26	3.30	2.20
Potassium oxide,	2.01	2.03	2.06
Nitrogen,	6.21	6.61	6.28
Insoluble matter,	0.07	0.08	0.09

5. *Analyses, etc.* — Continued.

Calcium Sulphate.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	18.02
Calcium oxide,	32.40
Sulphuric acid,	42.08
Insoluble matter,	2.35

Burnt Lime.

[Sent on from Amherst, Mass.]

	Per Cent.
Calcium oxide,	88.64
Insoluble matter,	4.71

Nitrate of Soda.

[I., sent on from South Sudbury, Mass.; II., sent on from North Hadley, Mass.; III., sent on from Amherst, Mass]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	1.38	1.78	1.20
Sodium oxide,	–	–	38.90
Nitrogen,	15.56	15.77	15.81

Muriate of Potash.

[I., sent on from Hadley, Mass.; II., sent on from Richmond, Mass.; III., sent on from Amherst, Mass.]

	Per Cent.		
	I	II.	III.
Moisture at 100° C.,	1.40	1.30	1.09
Potassium oxide,	49.95	46.64	50.40
Insoluble matter,	–	0.44	–

5. *Analyses, etc.* — Continued.

Sulphate of Potash.

[Sent on from Richmond, Mass.]

	Per Cent.
Moisture at 100° C.,	6.17
Potassium oxide,	24.32
Insoluble matter,	0.56

Florida Phosphate Rock.

[I., sent on from Amherst; II., sent on from Fort Meade, Fla.; III. and IV., sent on from Vicksburg, Miss.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	2.24	13.62	1.59	1.38
Phosphoric acid,	21.67	22.42	23.96	23.71
Calcium oxide,	–	28.06	35.41	33.84
Ferric and aluminic oxides,	5.02	9.46	9.70	4.80
Insoluble matter,	34.67	23.30	4.68	9.52
Carbonic acid,	Trace.	–	–	–

Florida Phosphate Rock.

[I., II., III. and IV., from Oscala, Fla.; V., from Pitman, Fla.; VI., sent on from Boston, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	2.03	1.90	6.53	0.99	5.28	0.58
Phosphoric acid,	21.34	24.10	7.68	38.97	18.23	32.18
Calcium oxide,	–	–	–	–	–	29.78
Ferric and aluminic oxides,	2.53	2.42	2.84	1.20	3.11	15.85
Insoluble matter,	21.64	26.44	48.77	2.35	33.89	9.16

5. *Analyses, etc.* — Continued.

Dissolved Bone-black.

[I. and II., sent on from Amherst, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	18.50	15.15
Ash,	55.52	50.40
Total phosphoric acid,	15.35	17.55
Soluble phosphoric acid,	14.87	17.51
Reverted phosphoric acid,	0.29	–
Insoluble phosphoric acid,	0.19	–
Insoluble matter,	2.95	0.12

Superphosphate.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	14.23
Ash,	69.95
Total phosphoric acid,	14.64
Soluble phosphoric acid,	10.34
Reverted phosphoric acid,	2.42
Insoluble phosphoric acid,	1.88
Insoluble matter,	10.81

Fine-ground Bone.

[Sent on from Amherst, Mass.]

Mechanical Analysis.

	Per Cent.
Fine,	48.57
Fine medium,	24.20
Medium,	20.59
Coarse medium,	6.64

Chemical Analysis.

Moisture at 100° C.,	8.40
Ash,	54.81
Total phosphoric acid,	15.16
Soluble phosphoric acid,	2.33
Reverted phosphoric acid,	6.42
Insoluble phosphoric acid,	6.41
Nitrogen,	3.89
Insoluble matter,	0.42

5. *Analyses, etc.* — Continued.

Tankage.

[I., sent on from Worcester, Mass.; II., sent on from Hadley, Mass.; III., sent on from Lexington, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	5.78	6.05	40.92
Ash,	49.57	35.58	28.53
Total phosphoric acid,	18.86	8.65	7.39
Soluble phosphoric acid,	0.54	0.05	Trace.
Reverted phosphoric acid,	9.88	5.39	4.30
Insoluble phosphoric acid,	8.38	3.21	3.09
Nitrogen,	4.16	5.04	4.73
Insoluble matter,	1.48	2.62	0.40

Dry Ground Fish.

[I., sent on from Hadley, Mass.; II., sent on from North Hadley, Mass.; III., sent on from Amherst, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	10.54	9.12	13.66
Ash,	17.45	20.13	19.23
Total phosphoric acid,	6.75	7.04	7.39
Soluble phosphoric acid,	0.75	0.27	–
Reverted phosphoric acid,	3.25	3.10	–
Insoluble phosphoric acid,	2.75	3.67	–
Nitrogen,	7.64	8.47	9.16
Insoluble matter,	1.06	2.85	2.39

5. *Analyses, etc.* — Continued.

Fish Chum.

[Sent on from Beverly, Mass.]

	Per Cent.
Moisture at 100° C.,	6.46
Ash,	25.33
Total phosphoric acid,	9.15
Soluble phosphoric acid,	0.56
Reverted phosphoric acid,	5.99
Insoluble phosphoric acid,	2.60
Nitrogen,	5.50
Insoluble matter,	1.12

Wool Waste from Factories.

[I., shoddy mill waste, sent on from Lawrence, Mass.; II., wool waste, sent on from Spencer, Mass.; III., wool refuse, sent on from Gilbertville, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C,	11.28	43.05	27.05
Ash,	12.23	3.93	38.84
Potassium oxide,	0.14	0.06	0.42
Phosphoric acid,	0.08	0.05	0.07
Nitrogen,	3.44	6.67	1.05
Insoluble matter,	7.52	1.08	34.00

The best use which can be made of this class of refuse materials is to incorporate them into the barn-yard manure; they are essentially a nitrogenous source of plant food. Their commercial manurial value depends on their percentage of nitrogen. From seven to eight cents per pound of the latter is a fair basis of valuation.

Cotton Waste.

[Sent on from Fall River, Mass.]

	Per Cent.
Moisture at 100° C.,	5.63
Ash,	60.68
Potassium oxide,	0.66
Phosphoric acid,	0.26
Nitrogen,	0.96
Insoluble matter,	55.20

5. *Analyses, etc.* — Continued.

Tobacco Leaves.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	11.97
Ash,	20.48
Calcium oxide,	4.83
Magnesium oxide,	1.36
Ferric oxide,	0.22
Potassium oxide,	6.06
Phosphoric acid,	1.15
Nitrogen,	2.95
Insoluble matter,	2.35

The tobacco leaves contain more than twice the amount of mineral constituents found in the tobacco stems. The ash of the latter contains more phosphoric acid and potash than that of the former, while that of the leaves is richer in lime and magnesia than that of the stems.

Saltpetre Waste.

[Sent on from Littleton Common, Mass.]

	Per Cent.
Moisture at 100° C.,	1.23
Potassium oxide,	2.70
Sodium oxide,	47.99
Nitrogen,	0.61

The material contains usually a large amount of common salt, and may be used with good effect upon grass lands.

Waste from Lactate Factory.

[Sent on from Littleton Centre, Mass.]

	Per Cent.
Moisture at 100° C.,	34.11
Ash,	60.24
Calcium oxide,	22.55
Potassium oxide,	Trace.
Phosphoric acid,	0.67
Nitrogen,	0.68
Insoluble matter,	6.92

5. *Analyses, etc.* — Continued.

Muck.

[I., sent on from Brookline, Mass.; II., sent on from Fort Meade, Fla.; III. and IV., sent on from Boston, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	81.03	31.17	70.00	74.87
Organic matter,	10.96	4.18	14.84	14.46
Ash,	8.01	64.65	15.16	10.67
Calcium oxide,	–	–	0.28	0.14
Nitrogen,	0.36	0.06	0.49	0.46
Phosphoric acid,	–	–	0.17	0.073
Insoluble matter,	7.04	59.13	13.47	9.24

Peat.

[Sent on from Marshfield, Mass.]

	Per Cent.
Moisture at 100° C,	35.17
Ash,	21.92
Nitrogen,	1.16

Mud.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	22.45
Organic matter,	10.83
Ash,	66.72
Calcium oxide,	3.64
Potassium oxide,	0.25
Phosphoric acid,	Trace.
Nitrogen,	0.43
Insoluble matter,	29.26

5. *Analyses, etc.* — Continued.

Marl.

[I., sent on from West Springfield, Mass.; II., sent on from Marshfield, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	1.65	3.15
Calcium oxide,	47.61	0.37
Magnesium oxide,	0.58	1.71
Ferric oxide,	Trace.	Trace.
Potassium oxide,	Trace.	0.24
Phosphoric acid,	0.10	1.41
Carbonic acid,	34.03	None.
Insoluble matter,	2.81	79.73

Home-mixed Fertilizers.

[I., sent on from North Hadley, Mass.; II., sent on from Agawam, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C,	15.86	9.69
Ash,	63.56	39.20
Total phosphoric acid,	12.88	5.36
Soluble phosphoric acid,	8.24	1.69
Reverted phosphoric acid,	2.87	3.06
Insoluble phosphoric acid,	1.77	0.61
Potassium oxide,	5.97	8.28
Nitrogen,	1.53	4.30
Insoluble matter,	1.69	0.87

5. *Analyses, etc.* — Concluded.

Complete Fertilizers.

[I., sent on from Boston, Mass.; II, home-mixed fertilizer, sent on from Conway, Mass.; III. and IV., sent on from North Hadley, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	6.54	6.67	17.78	14.54
Ash,	46.27	49.21	50.12	48.42
Total phosphoric acid,	11.64	13.82	4.57	7.42
Soluble phosphoric acid,	7.78	6.27	1.77	6.90
Reverted phosphoric acid,	2.81	5.99	0.78	0.33
Insoluble phosphoric acid,	1.05	1.56	2.02	0.19
Potassium oxide,	4.29	4.98	10.72	7.19
Nitrogen,	3.66	3.44	5.14	3.75
Insoluble matter,	1.72	0.64	3.12	0.81

Complete Fertilizers.

[I., II. and III., sent on from South Sudbury, Mass.; IV, sent on from Sixteen Acres, Mass.; V. and VI., sent on from Richmond, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	18.05	15.92	16.54	12.43	12.14	13.54
Ash,	56.55	55.82	69.10	37.44	48.40	46.96
Total phosphoric acid,	8.47	11.68	10.26	8.05	9.44	10.87
Soluble phosphoric acid,	1.64	6.91	7.16	2.58	3.48	6.12
Reverted phosphoric acid,	3.67	1.19	1.69	3.27	3.24	3.59
Insoluble phosphoric acid,	3.16	3.58	1.36	2.20	2.72	1.16
Potassium oxide,	4.04	2.32	1.98	6.08	7.94	5.20
Nitrogen,	2.13	2.28	1.10	2.58	2.89	2.73
Insoluble matter,	3.58	5.37	6.72	1.10	1.82	0.64

6. *Miscellaneous Analyses.*

Paris Green.

[I. and II, sent on by the Gypsy Moth Commission from Boston, Mass.; III. and IV., sent on from Amherst, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	1.30	1.15	1.41	1.40
Copper oxide,	32.84	30.40	33.20	33.10
Arsenious oxide,	62.55	59.92	61.40	61.15
Insoluble matter,	0.21	0.10	0.09	0.64
Acetic acid,	3.10	8.43	3.90	3.71

Tobacco Liquor.

[Two samples sent on from Hyannis, Mass]

	PER CENT.	
	I.	II.
Nicotine,	4.55	4.82

Dalmation Insect Powder.

[Sent on from Boston, Mass]

	Per Cent.
Total ash,	15.52
Ash insoluble in hydrochloric acid,	9.20

No trace of mineral poisons was found. Under the microscope the vegetable matter had the general appearance of genuine pyrethrum powder.

6. *Miscellaneous Analyses* — Continued.

Carnation Pinks (Whole Plant).

[Sent on from Framingham, Mass.]

	Per Cent.
Moisture at 100° C.,	8.08
Ash,	8.80
Calcium oxide,	1.64
Magnesium oxide,	0.35
Ferric and aluminic oxides,	0.03
Sodium oxide,	1.13
Potassium oxide,	3.35
Phosphoric acid,	0.46
Nitrogen,	1.06
Insoluble matter,	0.21

Grapes.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	86.23
Ash,	0.5481
100 parts of ash contain: —	
Calcium oxide,	3.50
Magnesium oxide,	2.531
Ferric oxide,	1.193
Potassium oxide,	49.765
Phosphoric acid,	13.567
Nitrogen (in dry matter),	0.961

*Woods.**

[I, sound wood of plum; II., black knot of plum.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	6.590	7.990
Ash,	2.220	4.220
Calcium oxide,	0.684	0.690
Magnesium oxide,	0.119	0.232
Ferric oxide,	0.012	0.052
Potassium oxide,	0.387	1.438
Phosphoric acid,	0.132	0.475
Nitrogen,	0.570	1.450
Insoluble matter,	0.013	0.009

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* Collected off of the same tree, Amherst, Mass.

6. *Miscellaneous Analyses* — Continued.

Banana Skins.

[Sent on from Boston, Mass.]

	Per Cent.
Moisture at 100° C.,	13.99
Ash,	13.06
Calcium oxide,	1.44
Magnesium oxide,	0.11
Ferric and aluminic oxides,	0.26
Potassium oxide,	5.46
Phosphoric acid,	1.48
Nitrogen,	0.24

Analysis of the Ash.

Calcium oxide,	11.12
Magnesium oxide,	0.84
Ferric and aluminic oxides,	1.99
Potassium oxide,	41.80
Phosphoric acid,	11.33
Insoluble matter,	10.15

Sugar Beets.

[Sent on from Boston, Mass.]

Analysis of Beets.

	Per Cent.
Moisture at 100° C.,	77.35
Sugar by Fehling's test,	13.57
Sugar by polariscope,	13.59

Analysis of Juice.

Degrees Brix, corresponding for temperature,	21.2°
Specific gravity,	1.08869
Total solids,	20.52
Ash,	1.65
Sugar by Fehling's test,	16.02
Coefficient of purity,	78.05

Vinegar.

[I., sent on from Williamsburg, Mass.; II., III., IV., V., sent on from Prescott, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Specific gravity,	1.02565	1.00998	1.00732	1.01172	1.00448
Acetic acid,	4.80	4.66	4.82	5.27	3.97
Solid residue,	4.51	1.70	1.76	1.55	1.00

6. *Miscellaneous Analyses* — Continued.

Vinegar.

[Sent on from Amherst, Mass.]

	PER CENT.	
	I.	II.
Specific gravity,	1.01086	1.01206
Acetic acid,	5.02	5.15
Solid residue,	1.51	1.48

Vinegar Mash.

[Sent on from Boston, Mass. I., total solid residue on evaporation; II., residue from which liquid or soluble portion had been removed (insoluble residue).]

Average Composition.

	Per Cent.
Moisture at 100° C.,	94.49
Dry matter,	5.51
	100.00

Analysis of Dry Matter.

	PER CENT.	
	I.	II.
Crude ash,	3.03	2.92
" cellulose,	8.55	9.42
" fat,	8.45	7.77
" protein,	16.50	13.91
Non-nitrogenous extract matter,	63.47	65.98
	100.00	100.00
Nitrogen in dry matter,	2.64	2.22
Potassium oxide in dry matter,	0.84	0.34
Phosphoric acid in dry matter,	1.27	0.93
Acidity (calculated as acetic acid),	–	0.33

6. *Miscellaneous Analyses* — Continued.

Baking Powder.

[Sent on from Amherst, Mass.]

	Per Cent.
Total carbonic acid,	8.28
Phosphoric acid,	0.10
Sulphuric acid,	11.17
Aluminic oxide,	2.00

Analyses of Milk sent on for Examination.

[Per Cent.]

Number of Sample.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
1,	11.95	3.18	8.77	Lee.	
2,	11.96	3.51	8.45		Skim-milk.
3,	9.42	0.63	8.79		
4,	13.21	3.90	9.31	Millbury.	
5,	12.74	4.20	8.54	Lee.	
6,	9.24	0.28	8.96	Belchertown.	Buttermilk.
7,	11.18	2.92	8.26	Lawrence.	
8,	9.31	0.20	9.11	Tully.	Skim-milk.
9,	12.72	4.23	8.49	Amherst.	
10,	11.94	3.16	8.78		
11,	13.28	4.17	9.11		
12,	14.19	5.10	9.09	Warren.	
13,	12.84	3.85	8.99		
14,	14.10	4.54	9.56		
15,	13.28	3.79	9.49		
16,	13.18	3.87	9.31		
17,	13.98	4.73	9.25		
18,	15.76	5.95	9.81	Worcester.	
19,	14.47	4.30	10.17		
20,	15.93	6.40	9.53		
21,	16.68	6.75	9.93		
22,	16.64	6.92	9.72		
23,	15.39	5.85	9.54		
24,	13.64	4.43	9.21	Warren.	
25,	12.38	3.27	9.11		
26,	12.67	3.79	8.88		
27,	13.85	4.38	9.47		
28,	12.99	3.94	9.05		
29,	12.46	3.89	8.57		
30,	14.14	4.75	9.39	Warren.	
31,	13.17	3.65	9.52		
32,	13.14	4.33	8.81		
33,	12.84	4.61	8.23		
34,	11.95	3.62	8.33		
35,	13.10	4.22	8.88	Barre Plains.	
36,	10.58	2.79	7.79		
37,	13.52	4.73	8.79		
38,	12.21	3.85	8.36		

6. *Miscellaneous Analyses* — Concluded.

Analyses of Milk, etc. — Concluded.

Number of Sample.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
39,	12.19	3.63	8.56	Belchertown.	
40,	13.65	4.65	9.00	Barre Plains.	
41,	13.35	4.42	8.93		
42,	14.24	4.69	9.55		
43,	13.08	4.17	8.91		
44,	12.38	3.19	9.19		
45,	16.87	6.37	10.50		
46,	15.16	5.81	9.35		
47,	16.46	6.76	9.70	New Braintree.	
48,	16.00	6.51	9.49		
49,	15.41	6.13	8.28		
50,	16.61	7.33	9.28		
51,	15.31	5.58	9.73		
52,	16.05	6.40	9.65		
53,	13.04	4.63	8.41	Barre Plains.	
54,	12.72	3.83	8.89		
55,	11.10	3.27	7.83		
56,	11.28	3.59	7.69		
57,	11.68	4.78	6.90		
58,	11.15	3.91	7.24		
59,	13.32	4.62	8.70		
60,	12.29	4.56	7.73	North Adams.	
61,	15.23	6.92	8.31	North Adams.	
62,	13.25	4.25	9.00	Northborough.	

II. ANALYSES OF WATER SENT ON FOR EXAMINATION.

[Parts per Million.]

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
1	.084	.116	24.00	86.00	56.00	2.60	None.	Billerica.
2	.096	.144	16.00	80.00	50.00	–	–	Upton.
3	.120	.128	10.00	94.00	54.00	–	–	Upton.
4	.080	.136	5.00	12.00	6.00	–	–	Upton.
5	.112	.296	36.00	308.00	152.00	–	–	Upton.
6	.072	.104	4.00	86.00	60.00	2.86	None.	Amherst.
7	.052	.828	Trace.	36.00	20.00	1.27	None.	Sunderland.
8	.026	.070	8.00	98.00	44.00	1.27	–	Methuen.
9	.060	.108	Trace.	50.00	20.00	.95	None.	Cooleyville.
10	.088	.168	144.00	606.00	214.00	8.86	None.	North Amherst.
11	.020	.060	16.00	96.00	36.00	3.90	None.	Amherst.
12	.088	.092	34.00	150.00	96.00	2.60	None.	Plainville.
13	.640	.328	20.00	112.00	8.00	3.90	None.	Amherst.
14	–	–	56.00	–	–	–	–	Amherst.
15	–	–	24.00	–	–	–	–	Amherst.
16	.052	.136	Trace.	82.00	72.00	.16	None.	Westford.
17	.060	.140	Trace.	100.00	36.00	1.95	None.	Amherst.
18	.092	.204	Trace.	74.00	56.00	2.60	–	Amherst.
19	.140	1.480	48.00	322.00	48.00	5.29	None.	Weston.
20	.172	.176	12.00	146.00	26.00	2.60	None.	Amherst.
21	.050	.080	Trace.	56.00	26.00	1.27	Present.	Coolcyville.
22	.068	.072	Trace.	58.00	30.00	1.27	None.	Leverett.
23	.144	.120	Trace.	44.00	24.00	.32	None.	Westford.
24	.080	.148	28.00	314.00	154.00	6.00	None.	Natick.
25	.060	.052	20.00	154.00	86.00	4.57	None.	Amherst.
26	.108	.156	20.00	254.00	90.00	5.00	–	Agawam.
27	None.	.030	14.00	120.00	50.00	3.25	None.	North Amherst.
28	.040	.140	14.00	84.00	14.00	3.90	None.	Amherst.
29	.120	.080	8.00	80.00	50.00	1.27	None.	North Amherst.
30	–	–	–	–	–	–	Present.	North Amherst.
31	.200	.172	10.00	–	–	–	–	North Amherst.
32	.120	.072	Trace.	80.00	46.00	3.25	None.	Amherst.
33	1.680	.096	60.00	364.00	74.00	6.71	None.	Sunderland.

II. Analyses of Water, etc. — *Concluded.*

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
34	.112	.140	12.00	90.00	80.00	5.25	None.	Amherst.
35	.112	.180	46.00	210.00	80.00	3.25	-	North Hadley.
36	.076	.118	Trace.	40.00	10.00	1.27	Present.	North Amherst.
37	.296	.240	20.00	314.00	74.00	-	-	Amherst.
38	.016	.264	Trace.	88.00	10.00	1.95	Present.	Graniteville.
39	.014	.140	12.00	58.00	16.00	2.60	None.	Athol.
40	.020	.088	8.00	20.00	6.00	1.95	-	North Amherst.
41	.100	.070	2.00	90.00	20.00	2.60	-	North Amherst.
42	.010	.066	4.00	32.00	6.00	.48	None.	Cooleyville.
43	.016	.132	8.00	130.00	70.00	2.60	None.	Sunderland.
44	.074	.098	6.00	50.00	6.00	1.95	-	Amherst.
45	.020	.066	170.00	608.00	378.00	12.56	None.	Amherst.
46	.012	.066	2.00	258.00	176.00	14.84	None.	Richmond.
47	.040	.084	9.00	174.00	84.00	6.00	None.	North Hadley.
48	None.	.106	4.00	62.00	16.00	.48	None.	Amherst.
49	.108	.180	4.00	130.00	70.00	1.95	None.	West Brookfield.
50	.140	.120	27.00	216.00	116.00	6.00	None.	Foxborough.
51	.040	.230	16.00	170.00	74.00	9.57	None.	Amherst.
52	.010	.066	Trace.	90.00	54.00	2.99	None.	Amherst.
53	None.	.084	20.00	252.00	72.00	4.57	None.	Amherst.
54	.112	.140	7.00	136.00	56.00	2.60	-	Blackstone.
55	.120	.120	11.00	170.00	70.00	5.29	-	Amherst.
56	.128	.160	4.00	126.00	46.00	3.25	-	Amherst.
57	.038	.150	4.00	84.00	24.00	2.60	-	Hadley.
58	.024	.092	8.00	94.00	54.00	2.60	None.	North Hadley.
59	None.	.200	2.00	46.00	20.00	.48	-	Hawley.
60	.096	.128	6.00	130.00	30.00	1.95	-	Amherst.
61	None.	.170	Trace.	160.00	90.00	1.27	-	Moore's Corner.
62	.018	.098	13.00	180.00	90.00	6.71	None.	Springfield.
63	.014	.070	3.00	34.00	20.00	1.95	None.	Rutland.
64	.060	.148	6.00	114.00	44.00	1.95	-	Westhampton.
65	.004	.100	4.00	116.00	40.00	.48	None.	Belchertown.
66	.990	.440	15.00	164.00	54.00	2.47	None.	Weston.
67	.080	.270	9.00	105.00	45.00	2.73	None.	Weston.
68	.260	.964	34.00	237.00	130.00	-	-	Grafton.

The analyses have been made according to Wancklyn's process, familiar to chemists, and are directed towards the indication of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals, lead in particular. (For a more detailed description of this method, see "Water Analyses," by J. A. Wancklyn and E. T. Chapman.)

Mr. Wancklyn's interpretation of the results of his mode of investigation is as follows: —

1. Chlorine alone does not necessarily indicate the presence of filthy water.

2. Free and albuminoid ammonia in water, without chlorine, indicates a vegetable source of contamination.

3. More than five grains per gallon* of chlorine (= 71.4 parts per million), accompanied by more than .08 parts per million of free ammonia and more than .10 parts per million of albuminoid ammonia, is a clear indication that the water is contaminated with sewage, decaying animal matter, urine, etc., and should be condemned.

4. Eight-hundredths parts per million of free ammonia and one-tenth part per million of albuminoid ammonia render a water very suspicious, even without much chlorine.

5. Albuminoid ammonia, over .15 parts per million, ought to absolutely condemn a water which contains it.

6. The total solids found in the water should not exceed forty grains per gallon (571.4 parts per million).

An examination of the previously stated analyses indicates that Nos. 1, 2, 3, 4, 5, 10, 13, 18, 19, 20, 23, 24, 26, 29, 31, 32, 33, 34, 35, 37, 49, 50, 54, 55, 56, 60, 66, 67 and 68 ought to be condemned as unfit for family use; while Nos. 6, 9, 12, 16, 17, 22, 36, 41, 44 and 64 must be considered suspicious. From this record it will be seen that over two-fifths of the entire number of well waters tried proved unfit for drinking. Heating waters to the boiling point removes not unfrequently immediate danger.

Parties sending on water for analysis ought to be very careful to use clean vessels, clean stoppers, etc. The samples should be sent on without delay after collecting. One gallon is desirable for the analysis.

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* One gallon equals 70,000 grains.

III. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF AGRICULTURAL CHEMICALS AND REFUSE MATERIALS USED FOR FERTILIZING PURPOSES.

PREPARED BY R. B. MOORE.

[As the basis of valuation changes from year to year, no valuation is stated.]

1868-1892.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1891, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years. C. A. G.

	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc.																							
Muriate of potash,	57	2.00	-	-	-	-	58.98	45.94	**51.48**	-	-	-	-	-	-	6.69	-	.55	-	-	-	48.80	.70
Sulphate of potash,	20	2.54	-	-	-	-	51.28	21.36	**33.40**	-	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75
Sulphate of potash and magnesia,	15	4.75	-	-	-	-	29.48	16.96	**23.50**	-	-	-	-	-	-	6.25	2.57	-	-	44.25	-	2.60	1.41
Kainite,	4	3.20	-	-	-	-	16.48	12.51	**13.54**	-	-	-	-	-	-	18.97	1.15	9.80	-	20.25	-	33.25	2.13
Carnallite,	1	-	-	-	-	-	-	-	**13.68**	-	-	-	-	-	-	7.66	-	13.19	-	.56	-	41.56	-
Krugite,	1	4.82	-	-	-	-	-	-	**8.42**	-	-	-	-	-	-	5.27	12.45	8.79	-	31.94	-	6.63	14.96
Sulphate of magnesia (Kieserite),	9	22.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.82	17.30	-	36.10	-	-	5.73
Nitrate of potash,	2	1.93	-	14.58	11.60	**13.09**	45.62	44.76	**45.19**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate of soda,	22	1.40	-	16.01	14.44	**15.70**	-	-	-	-	-	-	-	-	-	35.50	-	-	-	-	-	.50	.50
Sulphate of ammonia,	24	1.00	-	21.68	19.70	**20.50**	-	-	-	-	-	-	-	-	-	-	-	-	-	60.00	-	-	-
Saltpetre waste,	11	2.60	-	3.30	.52	**2.28**	30.94	1.55	**14.34**	-	-	-	-	-	-	36.50	.75	.19	-	1.85	-	48.30	-
Nitre salt-cake,	2	6.03	-	-	-	**2.29**	-	-	**.87**	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3 92
Wood ashes,	189	12.50	-	-	-	-	10.80	2.32	**5.25**	5.58	.51	**1.70**	-	-	-	-	34.00	3.40	.90	-	-	-	12.50
Cotton-seed-hull ashes,	30	7.80	-	-	-	-	42.12	9.91	**22.50**	13.67	2.89	**8.50**	-	-	-	-	9.60	10.75	1.50	-	-	-	11.50
Ashes of spent tan-bark,	3	3.61	-	-	-	-	2.87	1.14	**2.04**	2.77	.13	**1.61**	-	-	-	-	33.46	3.55	-	-	-	-	24.33

Railroad-tie ashes,	1	4.70	-	-	-	-	-	-	.92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Peat ashes,	1	4.67	-	-	-	-	-	-	.46	-	-	.11	-	-	-	-	2.28	1.63	6.13	-	-	-	45.17
Logwood ashes,	1	1.50	-	-	-	-	-	-	.08	-	-	2.30	-	-	-	-	3.90	-	-	-	-	-	9.70
Hard-pine wood ashes,	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
Mill ashes,	1	.53	-	-	-	-	-	-	1.60	-	-	.46	-	-	-	-	34.93	1.35	-	-	-	-	36.36
Ashes from blue works	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
Sea-weed ashes,	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	63.65
Nova Scotia plaster,	10	6.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.85	.75	-	45.75	-	-	2.50
Onondaga plaster,	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.66	-	32.50	8.20	-	9.83
Gas-house lime,	3	22.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Lime waste from sugar factory,	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime-kiln ashes,	7	15.45	-	-	-	-	1.70	.02	.86	3.16	.36	1.18	-	-	-	-	44.80	2.60	-	-	17.75	-	8.25
Marls (Massachusetts),	7	13.70	-	-	-	-	-	-	.24	2.72	.06	1.05	-	-	-	-	40.50	.64	.69	-	28.57	-	3.44
Marls (Virginia),	2	15.98	-	-	-	-	.61	.37	.49	.09	.08	.09	-	-	-	-	7.25	.21	-	.66	7.25	-	64.23
Marl (North Carolina),	1	1.50	-	-	-	-	-	-	.04	-	-	.56	-	-	-	-	21.95	.61	-	-	-	-	50.18
II. Guanos, Phosphates, etc.																							
Peruvian guano,	26	14.81	37.61	13.50	4.44	7.85	4.08	1.14	2.61	20.60	5.96	15.26	4.57	3.79	6.90	-	-	-	-	-	-	-	6.60
Bat guano from Texas,	9	40.09	18.24	10.51	2.58	6.47	-	-	1.31	6.53	1.00	3.76	-	-	-	-	-	-	-	-	-	-	2.00
Cuba guano,	5	24.27	-	2.74	.63	1.67	-	-	-	16.16	11.54	13.35	-	-	-	-	-	-	-	-	-	-	3.17
Caribbean guano (orchilla),	12	7.31	-	-	-	-	-	-	-	35.43	18.11	26.77	-	-	-	-	39.95	3.29	-	2.68	-	-	1.27
Mona Island guano,	1	13.32	-	-	-	.76	-	-	-	-	-	21.88	-	7.55	14.33	-	37.49	-	-	-	-	-	2.45

	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
II. Guanos, Phosphates, etc.— Concluded.																							
South Carolina rock phosphate,	5	1.50	–	–	–	–	–	–	–	30.51	25.81	**28.03**	.27	.07	27.69	–	41.87	3.03	4.80	–	–	–	9.04
Florida rock phosphate,	22	2.25	–	–	–	–	–	–	–	38.97	6.95	**24.50**	–	–	–	–	28.50	–	7.25	–	–	–	28.75
Navassa phosphate,	2	7.60	–	–	–	–	–	–	–	34.45	34.09	**34.27**	–	–	–	–	37.45	–	10.27	–	–	–	2.70
Brockville phosphate,	1	2.50	–	–	–	–	–	–	–	–	–	**35.21**	–	–	–	–	–	–	–	–	–	–	6.46
Phosphatic slag,	4	1.45	–	–	–	–	–	–	–	30.51	18.91	**23.49**	–	3.06	21.65	–	48.66	3.42	10.12	–	–	–	9.40
Dissolved bone-black,	2	7.50	47.50	–	–	–	–	–	–	17.54	15.35	**16.45**	15.60	.60	.19	–	–	–	–	–	–	–	1.50
Bone-black,	5	4.60	–	–	–	–	–	–	–	30.54	16.56	**28.28**	–	–	–	–	–	–	–	–	–	–	3.64
South American bone-ash,	1	7.00	–	–	–	–	–	–	–	–	–	**35.89**	–	–	–	–	44.89	–	–	–	–	–	4.50
Acid phosphate,	1	14.23	69.95	–	–	–	–	–	–	–	–	**14.64**	10.34	2.42	1.88	–	–	–	–	–	–	–	10.81
III. Refuse Substances.																							
Dried blood,	14	12.50	6.37	13.55	8.10	**10.52**	–	–	–	6.23	1.53	**1.91**	–	–	–	–	–	–	–	–	–	–	–
Ammonite,	1	5.88	–	–	–	**11.33**	–	–	–	–	–	**3.43**	–	–	–	–	–	–	–	–	–	–	1.38
Oleomargarine refuse,	1	8.54	14.42	–	–	**12.12**	–	–	–	–	–	**.88**	–	–	–	–	–	–	–	–	–	–	.96
Felt refuse,	1	29.24	33.53	–	–	**5.26**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sponge refuse,	1	7.25	–	–	–	**2.43**	–	–	–	–	–	**3.19**	–	–	–	–	3.94	1.27	–	–	–	–	39.05

Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	-	.24
Raw wool,	1	6.95	7.54	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste,	7	15.80	24.10	10.20	1.05	5.70	3.08	.06	1.20	.67	.05	.35	-	-	-	-	.11	.06	.80	-	-	-	8.20
Wool washings (water),	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
Wool washings (acid),	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings (alkaline),	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	-	.92	.04	-	-	-	-	-	.22
Meat mass,	5	12.09	13.60	11.50	9.69	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	-	-	-	-	-	.58
Bone soup,	1	82.92	7.07	-	-	1.14	-	-	-	-	-	1.26	-	-	-	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	1	14.80	8.40	-	-	9.97	-	-	-	-	-	.53	-	-	-	-	-	-	-	-	-	-	.64
Dried soup from rendering cattle feet,	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.46	-	-	-	-	-	-	-	-	-	-	.26
Dried soup from horse rendering,	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-	-	-	-	-	-
Soap-grease refuse,	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	-	-	-	-	-	1.29
Bones,	134	7.50	55.90	4.70	1.62	4.05	-	-	-	32.52	15.16	23.25	.40	7.60	15.75	-	-	-	-	-	-	-	1.10
Tankage,	16	12.50	30.40	8.07	4.16	6.65	-	-	-	18.86	7.39	11.25	.30	5.10	5.85	-	-	-	-	-	-	-	1.35
Fish with less than twenty per cent. water,	59	12.75	21.50	11.40	6.81	7.25	-	-	-	11.26	5.50	8.25	.55	2.60	5.10	-	-	-	-	-	-	-	2.20
Fish with between twenty and forty per cent. water,	9	29.34	19.14	7.41	4.22	5.81	-	-	-	8.32	4.68	7.25	.82	2.87	3.56	-	-	-	-	-	-	-	1.85
Fish with more than forty per cent. water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Whale meat, raw,	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells,	1	7.27	-	-	-	4.50	-	-	-	-	-	3.52	-	-	-	-	22.24	1.30	-	-	-	-	.27
Castor-bean pomace,	4	9.98	5.70	5.72	5.33	5.56	1.70	.64	1.12	2.22	1.57	2.16	-	-	-	-	.87	.29	-	-	-	-	1.75
Cotton-seed meal,	13	7.75	5.90	7.26	4.02	6.55	2.09	.89	1.70	3.36	1.26	2.10	-	-	-	-	.39	.99	-	-	-	-	.40
Rotten brewer's grain,	1	78.77	-	-	-	.72	-	-	.04	-	-	.43	-	-	-	-	.26	.15	-	-	-	-	.59

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances — Concluded.																							
Tobacco stems,	6	10.61	14.07	2.91	.90	2.29	8.82	3.76	6.44	2.09	.44	.60	–	–	–	.34	3.89	1.23	–	–	–	–	.82
Cotton waste, wet,	1	34.69	–	–	–	1.30	–	–	.80	–	–	1.54	–	–	–	–	2.45	1.13	–	–	–	–	41.33
Cotton waste, dry,	3	6.44	60.60	2.09	.96	1.50	1.62	.66	1.10	.84	.26	.52	–	–	–	–	–	–	–	–	–	–	45.00
Cotton dust,	1	34.46	50.93	–	–	.50	–	–	.19	–	–	.21	–	–	–	–	.90	.90	–	–	–	–	47.46
Glucose refuse,	1	8.10	–	–	–	2.62	–	–	.15	–	–	.29	–	–	–	–	.18	.02	–	–	–	–	.07
Waste from lactate factory,	1	34.11	–	–	–	.68	–	–	–	–	–	.67	–	–	–	–	22.59	–	–	–	–	–	6.92
Hop refuse,	1	8.98	–	–	–	.98	–	–	.11	–	–	.20	–	–	–	–	.27	.10	–	–	–	–	.63
Banana skins,	1	13.99	–	–	–	.24	–	–	5.46	–	–	1.80	–	–	–	–	–	–	–	–	–	–	–
Sumac waste,	1	63.06	6.80	–	–	1.19	–	–	3.25	–	–	–	–	–	–	–	1.14	3.25	–	–	–	–	2.25
Eel-grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	–	–	–	1.63	2.13	.11	–	–	–	–	1.06
Rockweed, green,	1	68.50	23.70	–	–	.62	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rockweed, dry,	1	10.68	35.75	–	–	1.45	–	–	4.89	–	–	2.75	–	–	–	7.90	7.66	.21	–	–	–	–	10.40
Jute waste,	1	13.10	–	–	–	1.50	–	–	.08	–	–	.72	–	–	–	–	–	–	–	–	–	–	–
Starch waste from rubber factory,	1	10.01	.23	–	–	.02	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sludge from sewage precipitating tanks,	1	88.49	9.50	–	–	.05	–	–	.05	–	–	.10	–	–	–	–	1.58	.39	6.22	–	–	–	.93
Wet kelp,	1	88.04	2.26	–	–	.26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Blue-green algæ (*Lyngbia majuscula*), dry,	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Mussel mud, wet, ...	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry, ...	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60
Salt mud, ...	2	53.37	41.19	.40	.39	.40	.33	.32	.33	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
Fresh-water mud, ...	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Muck, ...	14	57.50	13.75	2.54	.26	1.05	-	-	-	.17	.08	.13	-	-	-	-	-	-	-	-	-	-	11.35
Peat, ...	10	61.50	8.20	1.40	.41	.85	-	-	.18	-	-	.08	-	-	-	-	.52	.72	2.14	-	-	-	2.20
Turf, ...	2	19.29	6.36	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soot, ...	1	5.54	77.10	-	-	-	-	-	1.83	-	-	-	-	-	-	-	-	-	-	-	-	-	35.34
IV. Animal Excrement, etc.																							
Barn-yard manure, ...	24	68.87	8.36	.67	.26	.49	.80	.13	.43	.75	.13	.32	-	-	-	-	.30	.19	-	-	-	-	5.40
Poudrette, dry, ...	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	-	-	-	-	-	-	4.65
Hen manure, fresh, ...	2	52.35	24.75	1.20	.79	.99	.32	.18	.25	1.00	.47	.74	-	-	-	-	1.19	.89	-	1.24	-	-	23.50
Hen manure, dry, ...	1	8.35	-	-	-	2.13	-	-	9.94	-	-	2.02	-	-	-	-	2.22	.62	-	-	-	-	34.64

IV. COMPILATION OF ANALYSES OF FODDER ARTICLES, FRUITS, SUGAR-PRODUCING PLANTS, DAIRY PRODUCTS, ETC.,

MADE AT

AMHERST, MASS.

1868-1892.

PREPARED BY R. B. MOORE.

A. ANALYSES OF FODDER ARTICLES.

B. ANALYSES OF FODDER ARTICLES WITH REFERENCE TO FERTILIZING INGREDIENTS.

C. ANALYSES OF FRUIT.

D. ANALYSES OF SUGAR-PRODUCING PLANTS.

E. DAIRY PRODUCTS.

F. INSECTICIDES.

A. *Analyses of Fodder Articles.*

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN — PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.	Nutritive Ratio (Average).
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
I. Green Fodders.																		
Fodder corn,	24	30.53	10.33	19.50	17.19	7.62	10.22	6.10	1.42	2.41	63.13	42.02	55.59	31.53	19.26	25.90	5.88	1:8.10
Fodder corn ensilage,	30	37.43	13.12	22.25	12.58	5.98	8.12	6.49	1.82	3.83	65.69	42.99	55.26	38.92	17.67	27.44	5.35	1:10.22
Corn and soja bean ensilage,	1	–	–	28.97	–	–	15.27	–	–	5.35	–	–	40.50	–	–	37.84	11.04	1:5.32
Sorghum,	6	23.18	12.38	17.41	11.84	7.46	8.74	2.00	1.21	1.55	64.93	47.65	56.15	29.27	22.00	26.73	6.83	1:11.85
Common millet,	9	49.29	21.32	35.42	12.16	5.43	7.50	3.99	2.09	2.74	58.61	46.39	53.89	33.98	24.88	30.99	4.84	–
Japanese millet (white head),	3	26.24	20.95	24.76	10.98	7.26	8.72	2.64	1.94	2.33	50.87	46.71	49.60	38.90	30.12	34.47	4.88	–
Japanese millet (red head),	6	33.83	22.66	27.33	7.99	4.92	6.90	2.45	1.58	2.01	60.83	50.11	52.91	35.29	25.21	32.10	6.08	–
White kibi,	2	24.26	22.85	23.56	15.14	10.79	12.97	1.61	1.50	1.56	53.66	52.30	52.91	31.70	23.03	27.37	5.19	–
Mochi millet,	3	42.29	30.07	37.42	11.90	6.11	9.94	1.94	1.74	1.81	67.08	49.06	55.69	29.80	20.01	25.56	7.00	–
Mix,	3	31.36	18.17	24.45	16.70	9.81	13.53	2.48	1.35	1.86	52.30	47.75	51.27	27.44	26.82	27.06	6.28	–
Green oats,	5	28.82	15.51	20.03	20.47	7.05	13.85	3.32	2.02	2.68	50.69	40.81	45.90	33.12	25.20	29.70	7.87	1:9.97
Timothy (*Phleum pratense* L.),	2	35.00	34.26	34.63	8.83	8.20	8.52	2.07	1.95	2.01	51.33	51.23	51.27	33.23	32.50	32.87	5.33	1:12.26
Hungarian grass (*Setaria Italica* Beauv.),	1	–	–	25.93	–	–	9.38	–	–	1.01	–	–	57.80	–	–	24.66	7.15	1:6.86
Vetch and oats (one part vetch and nine parts oats),	3	24.04	13.89	18.97	10.76	8.83	10.06	2.74	2.29	2.53	49.85	40.10	44.75	35.81	30.77	33.59	9.07	1:7.06
Horse bean, whole plant (*Vicia faba* L.),	1	–	–	15.17	–	–	16.68	–	–	2.31	–	–	47.09	–	–	28.17	5.75	1:2.71
Soja bean (whole plant, *Soja hispida* Mönch),	10	36.36	18.54	23.58	22.19	13.71	16.45	8.98	2.71	4.84	47.89	40.80	44.50	31.89	21.67	26.47	7.74	1:4.20

Cow-pea vines (*Dolichos sinensis* L.),	3	21.19	18.15	19.63	17.93	11.24	14.59	2.99	1.81	2.48	60.62	46.13	52.42	25.88	21.87	23.59	6.92	1:5.82
Serradella (*Ornithopus sativus* Brot.),	2	19.42	15.40	17.41	17.75	12.17	14.96	2.65	2.09	2.37	41.54	35.45	38.49	38.76	26.21	32.49	11.69	1:4.67
White lupine (*Lupinus albus* L.),	1	-	-	14.65	-	-	18.71	-	-	2.41	-	-	42.67	-	-	31.18	5.03	-
Spanish moss (*Tillandsia usneoides* L.),	1	-	-	39.20	-	-	4.45	-	-	2.54	-	-	57.73	-	-	32.61	2.67	-
II. Hay and Dry Coarse Fodders.																		
English hay (mixed hays),	10	91.94	86.96	89.73	11.93	8.47	9.60	2.77	1.56	2.30	54.72	47.11	50.03	35.55	29.21	31.90	6.17	1:11.83
Rowen of mixed hays,	14	91.16	75.55	81.93	14.70	11.63	12.75	5.03	2.60	3.56	53.52	41.92	50.00	31.50	24.25	26.39	7.30	1:6.83
Timothy hay,	6	92.76	81.26	89.39	9.37	7.24	8.66	2.65	1.95	2.22	54.43	50.01	51.55	36.59	29.21	32.90	4.88	1:11.94
Red-top hay (*Agrostis vulgaris* With.),	4	93.19	91.76	92.30	8.40	6.41	7.88	1.69	1.50	1.60	54.74	50.32	52.63	34.11	31.12	32.92	4.97	1:12.06
Kentucky blue-grass (*Poa pratensis* L.),	2	96.10	93.22	94.66	8.78	8.65	8.72	2.08	2.03	2.06	49.61	44.11	46.29	36.84	32.21	34.58	8.35	1:10.38
Orchard grass (*Dactylis glomerata* L.),	4	91.62	90.86	91.17	11.29	7.57	8.99	3.56	2.40	2.91	47.34	43.50	46.15	35.79	34.12	34.89	7.05	1:10.47
Meadow fescue (*Festuca pratensis* Hnds.),	5	94.70	87.84	91.09	7.85	5.89	6.76	2.17	1.65	1.87	49.18	42.03	46.31	39.90	34.61	36.93	8.13	1:13.69
Perennial rye-grass (*Lolium perenne* L.),	4	93.64	90.50	92.60	16.56	6.59	11.71	3.15	1.59	2.37	55.77	38.82	48.14	30.86	26.79	29.64	8.14	1 :7.40
Italian rye-grass (*Lolium Italicum* A. Br.),	4	92.62	90.70	91.54	9.75	6.20	8.15	2.07	1.39	1.85	52.80	43.09	49.14	36.90	31.27	33.34	7.52	1:10.90
Hungarian grass,	1	-	-	92.55	-	-	9.45	-	-	2.22	-	-	50.64	-	-	31.96	5.73	1:6.22
Barn-yard grass (*Panicum crus-galli* L.),	1	-	-	93.35	-	-	15.27	-	-	1.95	-	-	30.24	-	-	33.72	10.02	1:2.94
Hay of black grass,	1	-	-	91.25	-	-	6.72	-	-	3.37	-	-	49.47	-	-	31.41	9.03	-
Low meadow hay,	1	-	-	91.99	-	-	9.51	-	-	1.88	-	-	46.27	-	-	35.59	6.75	-
Salt hay,	2	91.92	90.34	91.13	4.35	3.77	4.06	3.24	2.65	2.95	60.15	60.14	60.15	27.84	27.82	27.83	5.02	-
Millet,	6	93.85	90.25	92.54	8.88	7.09	7.81	3.63	.89	2.05	55.80	49.62	51.74	35.91	29.80	33.32	5.08	1:7.78
Oats in bloom,	1	-	-	93.57	-	-	6.58	-	-	2.92	-	-	50.03	-	-	34.06	6.41	1 :14.23
Oats in milk,	1	-	-	90.45	-	-	10.89	-	-	2.69	-	-	46.02	-	-	34.32	6.08	1:7.90

A. Analyses of Fodder Articles — Continued.

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN—													Nutritive Ratio (Average).
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.	
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
II. Hay and Dry Coarse Fodders — Concluded.																		
Oats, ripe,	1	–	–	91.30	–	–	6.05	–	–	2.61	–	–	48.92	–	–	36.31	6.11	1:15.03
Winter rye in bloom,	1	–	–	91.45	–	–	10.66	–	–	2.57	–	–	47.40	–	–	32.97	6.40	1:8.28
Barley in milk,	1	–	–	89.75	–	–	10.26	–	–	2.76	–	–	52.91	–	–	29.12	4.95	1:9.59
Japanese buckwheat,	1	–	–	94.29	–	–	10.80	–	–	2.22	–	–	38.60	–	–	36.02	12.36	–
Dry fodder corn,	4	93.35	90.58	92.11	9.31	6.17	7.74	2.76	1.11	1.84	58.89	53.86	55.97	33.75	23.03	29.31	5.14	1:10.98
Corn stover,	26	94.44	75.00	88.18	12.15	5.46	7.29	2.63	1.08	1.38	63.05	44.65	50.82	38.83	20.93	34.84	5.67	1:11.62
Teosinte (*Euchlæna luxurians* Dur. and Asch.),	1	–	–	93.94	–	–	9.71	–	–	1.28	–	–	53.18	–	–	28.88	6.95	–
Mammoth red clover (*Trifolium medium* L.),	3	92.66	82.47	88.59	18.50	14.06	15.75	2.25	1.86	2.13	48.98	46.51	44.77	33.72	20.16	27.51	9.84	1:5.10
Medium red clover (*Trifolium pratense* L.),	2	94.90	93.98	94.44	15.01	14.63	14.82	2.62	2.36	2.49	43.88	42.81	43.34	30.76	29.97	30.37	8.98	1:5.52
Alsike clover (*Trifolium hybridum* L.),	6	93.92	86.48	90.07	17.55	14.77	16.63	3.26	1.88	2.58	46.64	38.03	42.72	32.34	21.44	26.17	11.90	1:3.25
Lucerne (alfalfa) (*Medicago sativa* Desr.),	5	95.40	84.00	91.40	16.34	11.12	14.22	2.50	1.04	1.65	51.62	40.25	46.20	34.39	25.42	29.72	8.11	1:4.09
Sand lucerne (*Medicago media* Pers.),	1	–	–	91.20	–	–	16.26	–	–	2.59	–	–	50.31	–	–	21.27	9.57	1:3.50
Bokhara clover (*Melilotus alba* Desr.),	2	93.64	91.50	92.57	14.93	11.81	13.37	4.79	1.85	3.32	51.36	38.83	45.08	33.05	28.08	30.57	7.66	–
Blue melilot (*Melilotus cœrulea* Desr.),	1	–	–	91.78	–	–	13.81	–	–	1.67	–	–	43.22	–	–	27.17	14.87	–
Sainfoin (*Onobrychis sativa*),	1	–	–	87.83	–	–	17.70	–	–	4.49	–	–	42.27	–	–	26.95	8.54	–
Sulla (*Hedysarum coronarium*),	2	91.68	89.59	90.61	17.03	16.90	16.97	3.16	2.39	2.78	58.66	41.89	50.26	28.95	12.38	20.67	9.32	–

Hairy lotus (*Lotus villosus* Thuill),	2	89.32	87.64	88.48	16.12	13.49	14.81	3.00	2.69	2.85	57.82	50.80	54.29	24.48	15.07	19.78	8.27	–
Soja bean,	3	93.88	79.91	89.10	19.06	15.10	16.68	8.33	5.62	6.77	51.28	41.09	46.96	25.84	20.76	22.79	6.90	1:4.23
Cow pea,	3	90.70	90.25	90.43	17.17	16.95	17.05	4.49	3.81	4.06	51.41	46.06	47.93	23.58	19.06	21.67	9.29	1:4.82
Small pea (*Lathyrus sativus*),	1	–	–	94.20	–	–	16.57	–	–	1.49	–	–	42.76	–	–	32.88	6.30	–
Serradella,	3	92.80	87.23	90.44	17.97	15.26	17.03	2.91	2.37	2.55	50.23	44.49	48.18	25.92	24.37	25.15	7.09	1:4.85
Hairy vetch (*Vicia villosa* Roth.),	1	–	–	92.56	–	–	19.58	–	–	1.22	–	–	38.95	–	–	31.88	8.37	–
Common vetch (*Vicia sativa* L.),	2	91.65	90.55	91.10	15.76	14.42	15.09	2.69	2.30	2.50	44.34	43.29	43.80	30.68	30.05	30.37	8.24	1:3.87
Scotch tares,	1	–	–	84.20	–	–	22.00	–	–	1.89	–	–	31.46	–	–	30.89	13.76	–
Vetch and oats,	2	94.22	87.47	90.85	7.72	7.70	7.71	3.37	2.53	2.95	49.95	49.00	49.47	36.22	31.73	33.98	5.89	1:11.49
Horse-bean straw,	1	–	–	90.85	–	–	9.69	–	–	1.51	–	–	37.77	–	–	41.44	9.59	1:8.55
Soja-bean straw,	1	–	–	87.00	–	–	5.39	–	–	1.80	–	–	43.72	–	–	43.85	5.24	–
White daisy (*Chrysanthemum leucanthemum* L.),	1	–	–	90.35	–	–	7.68	–	–	2.32	–	–	46.86	–	–	36.09	7.05	–
Dry carrot tops,	1	–	–	90.24	–	–	20.12	–	–	2.01	–	–	50.39	–	–	13.61	13.87	–
Wheat straw,	1	–	–	93.80	–	–	7.20	–	–	1.63	–	–	50.46	–	–	35.91	4.80	1:8.00
Barley straw,	1	–	–	88.56	–	–	9.24	–	–	3.38	–	–	48.23	–	–	33.85	5.30	1:26.21
Japanese millet (white head),	1	–	–	91.48	–	–	7.67	–	–	2.41	–	–	49.87	–	–	34.99	5.06	–
Japanese millet (red head),	1	–	–	91.13	–	–	5.76	–	–	1.70	–	–	49.66	–	–	39.52	3.36	–
III. Roots, Bulbs, Tubers, etc.																		
Beets, red,	7	14.51	9.75	12.17	15.40	7.82	12.29	1.76	.59	.94	79.33	66.87	72.19	7.56	4.29	6.00	8.58	1:8.24
Beets, sugar,	11	19.53	9.87	14.73	17.44	7.32	10.97	.83	.58	.66	81.50	61.93	75.93	9.69	4.82	6.49	5.95	1:11.80
Mangolds,	3	13.08	11.73	12.25	12.84	7.83	10.37	1.01	.73	.88	73.38	70.32	71.75	9.54	7.08	7.94	9.06	1:8.83
Beets, yellow fodder,	1	–	–	9.40	–	–	12.78	–	–	1.80	–	–	67.50	–	–	7.83	10.09	1:9.94

A. Analyses of Fodder Articles — Continued.

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN —													Nutritive Ratio (Average).
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.	
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
III. Roots, Bulbs, Tubers, etc.—Concluded.																		
Ruta-bagas,	3	12.77	8.25	10.88	11.46	10.34	11.01	2.32	1.23	1.53	68.58	62.27	65.88	13.12	11.03	11.83	9.75	1:11.83
Turnips,	3	12.80	8.22	9.79	10.81	9.67	10.12	2.05	1.42	1.74	70.62	65.91	68.44	12.61	10.12	11.23	8.47	1:13.26
Carrots,	4	12.52	9.95	10.72	9.63	7.98	8.93	3.94	1.67	2.34	73.96	67.24	71.27	10.76	7.55	9.19	8.27	1:9.67
Parsnips,	1	-	-	19.66	-	-	6.88	-	-	3.37	-	-	74.65	-	-	-	7.67	-
Potatoes,	10	21.95	13.91	18.78	13.56	6.24	10.01	.83	.17	.48	87.56	78.80	81.50	3.55	1.91	2.75	5.26	1:12.25
Apples,	2	24.83	19.68	22.26	4.57	3.92	4.25	2.81	1.71	2.26	86.21	83.44	84.81	7.05	6.14	6.60	2.08	1:26.44
IV. Grains and Other Seeds.																		
Corn kernels,	28	91.98	65.50	89.55	15.02	8.49	12.24	9.43	4.25	5.47	83.98	71.06	78.44	3.38	1.03	2.14	1.71	1:8.16
Corn and cob meal,	37	94.00	80.89	89.47	15.06	7.82	10.01	5.27	3.36	4.19	81.41	70.13	76.62	10.41	5.63	7.54	1.64	-
Wheat kernels,	1	-	-	89.42	-	-	13.35	-	-	1.79	-	-	80.20	-	-	2.42	2.18	1.6.42
Broom-corn seed,	1	-	-	85.90	-	-	11.21	-	-	4.05	-	-	74.05	-	-	8.34	2.35	-
Soja beans,	3	94.15	80.73	85.83	35.98	32.58	33.97	21.89	18.42	20.19	34.88	32.87	33.98	7.57	5.15	6.02	5.84	1:2.61
Horse beans,	1	-	-	89.72	-	-	30.03	-	-	1.11	-	-	56.48	-	-	8.11	4.27	1:2.24
Red adzinki beans,	2	85.18	83.10	84.14	25.14	23.75	24.45	.88	.76	.82	66.48	65.41	65.95	4.68	4.50	4.59	4.19	-
Saddle beans,	1	-	-	87.62	-	-	15.12	-	-	16.58	-	-	57.34	-	-	4.75	6.21	-

Daidzu beans,	1	-	-	88.47	-	-	38.99	-	-	18.59	-	-	30.41	-	-	4.97	7.04	-
Millet seed,	3	87.32	86.11	86.65	14.60	11.76	13.24	4.94	3.53	4.32	73.19	66.94	70.56	10.23	6.48	8.88	3.00	-
Chestnuts,	1	-	-	55.14	-	-	13.32	-	-	14.46	-	-	67.05	-	-	2.45	2.72	-
V. Flour and Meal.																		
Corn meal,	27	89.95	82.96	85.99	16.08	9.73	11.08	5.08	3.10	4.50	83.24	73.20	80.53	3.60	1.20	2.19	1.70	-
Hominy meal,	4	91.89	88.68	90.23	11.88	6.77	10.41	12.22	4.89	9.81	78.07	68.00	73.00	5.12	3.69	4.34	2.44	-
Ground barley,	3	87.81	82.59	85.59	14.93	10.42	12.17	2.38	1.69	2.09	78.25	74.47	76.69	7.37	5.04	6.42	2.63	-
Broom-corn meal,	1	-	-	86.46	-	-	11.14	-	-	4.13	-	-	74.30	-	-	8.00	2.43	-
Pea meal,	1	-	-	91.15	-	-	20.95	-	-	1.67	-	-	55.02	-	-	19.42	2.94	-
VI. By-products and Refuse.																		
Linseed cake, old process,	7	92.52	88.50	90.54	39.97	30.98	36.64	9.87	6.24	7.16	44.72	37.76	40.61	9.69	8.04	8.68	6.91	1:1.66
Linseed cake, new process,	5	94.94	88.17	92.05	41.02	35.03	39.18	4.08	2.17	3.12	46.49	40.83	41.87	10.31	8.93	9.38	6.45	1:1.32
Cotton-seed meal, decorticated,	14	93.16	88.81	91.32	51.79	36.54	44.43	14.72	9.57	12.23	33.87	20.22	27.18	10.83	6.28	8.11	8.05	1:1.39
Wheat bran,	32	92.58	86.30	89.44	20.54	15.67	17.71	6.08	2.80	4.99	62.18	51.77	59.39	14.26	7.49	10.90	7.01	-
Wheat middlings,	6	90.75	87.57	89.93	19.21	15.13	16.72	6.46	3.19	5.31	74.30	58.03	61.77	11.21	1.40	9.21	6.99	1:4.21
Rye bran,	2	91.82	86.30	89.06	18.98	16.52	17.75	3.03	2.07	2.55	73.56	69.24	71.70	4.54	3.46	4.00	4.30	1:4.88
Rye middlings,	1	-	-	87.46	-	-	13.15	-	-	5.61	-	-	73.52	-	-	3.70	4.02	1:7.28
Buckwheat middlings,	1	-	-	88.49	-	-	25.49	-	-	7.53	-	-	66.36	-	-	5.18	5.44	-
Gluten meal,	22	93.50	68.32	90.36	39.28	25.94	32.06	12.05	3.92	7.35	66.26	48.26	58.62	5.43	.41	1.26	.71	1:2.75
Maize feed,	1	-	-	90.25	-	-	21.33	-	-	6.15	-	-	62.12	-	-	9.65	.75	1:4.49
Corn germ meal,	1	-	-	90.65	-	-	28.26	-	-	11.82	-	-	42.49	-	-	9.18	8.25	-

A. *Analyses of Fodder Articles* — Concluded.

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN—													Nutritive Ratio (Average).
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.	
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
VI. By-products and Refuse — Concluded.																		
Bakery refuse,	1	-	-	86.66	-	-	9.23	-	-	6.36	-	-	72.34	-	-	.43	11.64	-
Vinegar mash,	1	-	-	5.51	-	-	16.50	-	-	8.45	-	-	63.47	-	-	8.55	3.03	-
Refuse from starch works,	1	-	-	42.96	-	-	22.41	-	-	10.17	-	-	58.98	-	-	7.54	.90	-
Spent brewer's grain,	4	93.02	88.00	90.13	33.16	16.08	23.29	6.29	1.95	4.89	67.62	42.32	54.04	15.90	8.07	11.25	4.53	1:2.90
Cocoa dust from cocoa manufactory,	1	-	-	92.90	-	-	15.47	-	-	25.85	-	-	45.99	-	-	5.86	6.83	-
Broom-corn waste,	1	-	-	91.30	-	-	6.78	-	-	1.00	-	-	48.09	-	-	39.25	4.88	-
Cotton hulls,	2	89.83	88.55	89.10	5.36	4.90	5.13	4.27	2.36	3.31	46.75	38.59	42.67	51.40	40.24	45.82	3.07	1:28.16
Apple pomace,	2	21.78	17.22	19.50	7.73	6.94	7.34	4.37	3.17	3.78	72.93	70.20	72.56	16.58	13.15	14.86	1.46	-
Apple pomace ensilage,	1	-	-	14.67	-	-	8.22	-	-	7.36	-	-	58.03	-	-	22.18	4.21	-
Sugar beet pulp, from diffusion battery,	1	-	-	10.32	-	-	12.41	-	-	.95	-	-	61.86	-	-	23.74	1.04	-
Corn cobs,	4	-	-	90.00	4.15	3.00	3.57	.67	.38	.57	63.62	60.58	61.78	33.77	31.36	32.93	1.21	1:30.85
Palmetto root,	1	-	-	88.49	-	-	3.82	-	-	.53	-	-	69.95	-	-	21.26	4.44	-

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients.*

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
I. Green Fodders.												
Fodder corn,	14	78.61	.407	4.84	.327	.048	.153	.091	.018	.148	.380	$1 65
Fodder corn ensilage,	1	71.60	.360	–	.330	.050	.100	.090	.020	.140	.040	1 53
Corn and soja bean ensilage,	1	71.03	.790	–	.444	–	–	–	–	.420	–	3 23
Sorghum,	7	82.19	.233	–	.229	.025	.076	.075	.012	.088	.136	1 00
White kibi,	2	76.45	.489	1.22	.200	.045	.232	.148	.019	.136	.652	1 79
Mochi millet,	3	62.58	.609	2.62	.407	.120	.201	.217	.021	.188	.708	2 50
Mix,	3	75.59	.499	1.54	.363	.060	.249	.245	.021	.237	.527	2 08
Green oats,	3	83.36	.489	1.31	.381	.217	.154	.134	.018	.130	.496	1 95
Vetch and oats,	1	86.11	.236	1.72	.789	.031	.087	.030	.012	.094	.331	1 53
Horse bean,	1	74.71	.675	–	1.370	.090	1.370	.620	.200	.330	2.040	3 62
Cow-pea vines,	1	78.81	.274	1.47	.306	.063	.300	.099	.016	.098	.077	1 21
Serradella,	2	82.59	.411	1.82	.420	.097	.460	.067	.021	.140	.097	1 77
White lupine,	1	85.35	.440	–	1.730	.680	3.070	.730	.170	.350	.900	3 26
Spanish moss,	1	60.80	.279	1.04	.255	.263	.089	.122	.029	.030	.191	1 10

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* The valuation is based on the following prices per pound of the essential fertilizing ingredients: Nitrogen, 15 cents; potassium oxide, 4½ cents; phosphoric acid, 5½ cents.

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients* — Continued.

NAME.	Analyses.	Moisture.	Nitrogen	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per 2,000 Pounds.
II. Hay and Dry Course Fodders.												
English hay,	9	11.99	1.409	6.34	1.550	.110	.344	.240	.021	.269	.980	$5 92
Rowen,	12	18.52	1.609	9.57	1.486	.140	.640	.280	.034	.432	1.840	5 64
Timothy hay,	3	11.26	1.240	4.93	1.460	.180	.620	.120	.006	.342	1.000	5 41
Red-top,	4	7.71	1.150	4.59	1.020	.438	.571	.134	.036	.360	1.736	4 76
Kentucky blue-grass,	2	5.34	1.320	-	1.694	.129	.398	-	.044	.431	2.863	5 95
Orchard grass,	4	8.84	1.310	6.42	1.879	.225	.456	.297	.033	.414	2.060	6 08
Meadow fescue,	6	8.89	.992	8.08	2.096	.301	.576	.187	.028	.399	1.537	5 30
Perennial rye grass,	2	9.13	1.227	6.79	1.553	.307	.642	.337	.044	.559	2.262	5 69
Italian rye-grass,	4	8.71	1.189	-	1.273	.451	.857	.321	.071	.556	2.598	5 32
Salt hay,	1	5.36	1.180	-	.718	.017	.371	.335	.028	.248	-	4 46
Japanese millet (white head),	3	10.45	1.105	5.80	1.223	.012	.465	.377	.028	.403	1.633	4 86
Japanese buckwheat,	1	5.72	1.629	-	3.320	.349	3.418	.421	.148	.852	.378	8 81
Fodder corn,	7	7.85	1.763	4.91	.889	.175	.605	.500	.075	.542	1.270	6 69
Corn stover,	16	9.12	1.043	3.74	1.400	.112	.622	.384	.068	.293	1.885	4 71
Teosinte,	1	6.06	1.460	6.53	3.696	.109	1.597	.458	.021	.546	.315	8 31
Millet hay,	1	9.75	1.280	-	1.690	.020	.500	.460	.030	.490	1.360	5 90

Mammoth red clover,	3	11.41	2.231	8.72	1.223	.389	3.141	.613	.111	.546	.779	8 39
Medium red clover,	2	7.91	2.184	8.36	2.286	.210	1.689	.402	.099	.447	.919	9 10
Alsike clover,	6	9.94	2.342	11.11	2.227	.309	2.153	.537	.197	.668	1.776	9 77
Lucerne (alfalfa),	4	6.26	2.075	6.82	1.461	.814	2.211	.406	.078	.526	.513	8 12
Bokhara clover,	2	7.43	1.975	7.70	1.832	.114	1.784	.347	.023	.558	.057	8 19
Blue melilot,	1	8.22	1.919	13.65	2.796	.270	1.449	.260	.349	.544	4.008	8 87
Sainfoin,	1	12.17	2.630	7.55	2.020	.540	1.160	.430	.040	.760	.470	10 54
Sulla,	2	9.39	2.460	–	2.093	.223	2.497	.350	.114	.453	.614	9 76
Lotus villosus,	2	11.52	2.095	8.23	1.807	.499	2.220	.476	.112	.594	.976	8 56
Soja bean,	2	6.30	2.320	6.47	1.079	.148	2.760	1.178	.115	.667	.977	8 66
Cow-pea,	1	9.00	1.635	8.40	.913	.122	2.696	.688	.046	.527	.832	6 31
Small pea,	1	5.80	2.497	–	1.990	.469	1.373	.276	.138	.592	1.081	9 93
Serradella,	2	7.39	2.697	10.60	.652	.656	2.545	.461	.066	.777	.590	9 83
Scotch tares,	1	15.80	2.964	–	3.004	.238	1.698	.354	.460	.815	4.062	12 49
Vetch and oats,	3	9.91	1.299	9.58	1.349	.420	.663	.265	.098	.560	.521	5 72
Soja-bean straw,	1	13.00	.750	–	1.322	–	.436	.469	.035	.397	.218	3 88
White daisy,	1	9.65	.279	6.37	1.253	.164	1.302	.191	.032	.435	1.110	2 44
Dry carrot tops,	1	9.76	3.130	12.52	4.883	4.028	2.089	.667	.118	.612	.098	14 46
Barley straw,	1	11.44	1.310	5.30	2.086	.183	.572	.180	–	.303	2.380	6 14
III. Roots, Bulbs, Tubers, etc.												
Beets, red,	7	87.73	.243	1.13	.436	.091	.049	.033	.004	.091	.020	1 22
Beets, sugar,	4	86.95	.223	1.04	.477	.081	.057	.040	.013	.101	.048	1 21

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per 2,000 Pounds.
III. Roots, Bulbs, Tubers, etc. — Concluded.												
Beets, yellow fodder,	1	90.60	.192	.95	.462	.104	.045	.030	.005	.086	.015	$1 09
Mangolds,	2	87.29	.188	1.22	.383	.125	.061	.039	.005	.093	.023	1 01
Ruta-bagas,	3	89.13	.190	1.06	.489	.070	.088	.030	.004	.123	.012	1 15
Turnips,	2	89.49	.178	1.01	.385	.078	.089	.027	.009	.104	.055	0 99
Carrots,	2	89.79	.147	9.22	.506	.062	.067	.023	.009	.093	.019	1 00
Parsnips,	1	80.34	.217	–	.617	.006	.088	.045	.005	.187	.019	1 41
Potatoes,	1	79.75	.207	.99	.294	.013	.007	.020	.002	.066	.006	0 96
Apples,	2	79.91	.130	.41	.190	.030	.030	.030	.003	.010	.003	0 57
IV. Grains and Other Seeds.												
Corn kernels,	13	10.88	1.822	1.53	.404	.034	.032	.206	.019	.699	.020	6 60
Corn and cob meal,	29	8.96	1.409	–	.472	.059	.018	.176	.011	.571	.430	5 28
Soja beans,	2	18.33	5.303	4.99	1.991	.275	.419	.909	.216	1.869	.093	19 75
Red adzinki beans,	1	14.82	3.240	–	1.540	.035	.090	.210	.180	.940	.050	12 14
White adzinki beans,	1	16.90	3.330	–	1.480	.190	.130	.220	.021	.970	.130	12 39
Saddle beans,	1	12.38	2.120	–	2.130	.020	.250	.430	.032	1.520	.250	9 95

Daidzu beans,	1	11.53	5.520	-	1.960	.210	.220	.400	.050	1.480	.280	19 95
Japanese millet,	2	13.68	1.730	-	.380	.030	.045	.225	.015	.685	-	6 22
Common millet,	1	12.68	2.040	-	.360	.060	.040	.260	.030	.850	.143	7 38
Chestnuts,	1	44.86	1.175	2.72	.632	-	.060	.135	.010	.392	.069	4 53
V. Flour and Meal.												
Corn meal,	2	13.52	2.050	1.42	.435	.064	.034	.187	.015	.707	.005	7 31
Hominy feed,	1	8.93	1.630	2.21	.490	-	.180	.280	-	.980	-	6 41
Ground barley,	1	13.43	1.550	2.06	.341	.169	.091	.173	.013	.660	.669	5 68
Wheat flour,	1	9.83	2.210	1.22	.540	-	.170	.050	-	.570	-	7 74
Pea meal,	1	8.85	3.080	2.68	.993	.618	.302	.302	.027	.820	.122	11 04
VI. By-products and Refuse.												
Linseed cake, old process,	4	8.02	5.390	6.57	1.214	.860	.664	.763	.060	1.780	.340	19 22
Linseed cake, new process,	4	7.35	5.808	5.04	1.288	.823	.663	.655	.062	1.628	.345	20 37
Cotton-seed meal,	9	8.96	6.467	6.49	1.723	.291	.587	.589	.020	2.333	.457	23 52
Wheat bran,	5	11.39	2.879	6.44	1.625	.159	.168	.899	.019	2.845	.141	13 23
Wheat middlings,	1	9.18	2.630	2.30	.630	.110	.200	.210	-	.950	-	9 50
Rye middlings,	1	12.54	1.840	3.52	.810	.030	.090	.320	.020	1.260	.170	7 63
Gluten meal,	5	8.53	5.090	.65	.047	.018	.050	.035	.009	.420	-	15 77
Spent brewer's grain,	2	8.58	2.680	6.15	.853	.347	.296	.286	.159	1.045	1.770	9 96
Cocoa dust,	1	7.10	2.299	6.35	.630	-	.630	-	-	1.340	-	8 94
Broom-corn waste (stalks),	1	10.37	.870	4.70	1.858	-	.242	.170	-	.460	1.000	4 79

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Concluded.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per 2,000 Pounds.
VI. By-products and Refuse — Concluded.												
Cotton hulls,	3	10.63	.750	2.61	1.080	-	.200	.260	-	.180	.060	$3 42
Apple pomace,	2	80.50	.227	.271	.134	.026	.037	.028	.008	.018	.009	0 82
Corn cobs,	8	12.09	.504	.815	.598	.071	.025	.045	.009	.063	.190	2 12
Palmetto roots,	1	11.51	.540	3.93	1.380	.345	.045	.004	.017	.157	.410	3 03
Buckwheat hulls,	1	11.90	.490	-	.521	-	.247	.236	.020	.073	.066	2 02

C. Analyses of Fruits.

NAME.	Date.	Dry Matter.	Specific Gravity of Juice.	Temperature C. of Juice (Degrees).	Total Sugar in Juice.	Glucose in Juice.	Cane Sugar in Juice.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.	Per ct.			Per ct.	Per ct.	Per ct.	C. C.
Apple (Baldwin), . . .	Sept. 1,	20.14	1.055	12—15	3.09	–	–	–
Apple (Baldwin), . . .	Oct. 9,	19.66	1.065	12—15	6.25	–	–	–
Apple (Baldwin), . . .	Nov. 27,	–	1.075	12—15	10.42	–	–	–
Rhode Island Greening, . .	Sept. 1,	20.27	1.055	12—15	3.16	–	–	–
Rhode Island Greening, . .	Oct. 9,	19.68	1.066	12—15	7.14	–	–	–
Rhode Island Greening,† . .	Nov. 27,	20.25	1.080	12—15	11.36	–	–	–
Pear (Bartlett), . . .	Aug. 31,	15.00	1.060	12—15	4.77	–	–	–
Pear (Bartlett), . . .	Sept. 7,	16.55	1.060	12—15	5.68	–	–	–
Pear (Bartlett), . . .	Sept. 20,	–	1.065	12—15	8.62	–	–	–
Pear (Bartlett),‡ . . .	Sept. 22,	–	1.060	12—15	8.93	–	–	–
Cranberries, ...	–	10.71	1.025	15	1.35	–	–	–§
Cranberries, ...	1878.	10.11	1.025	15	1.70	–	–	–‖
Early York Peach (ripe), .	–	–	1.045	25	–	1.92	6.09	45
Early York Peach (nearly ripe),	–	10.96¶	1.039	25	–	1.36	4.12	42.3
Crawford Peach (nearly ripe),	–	–	1.050	18	–	2.19	7.02	85.6
Crawford Peach (mellow), .	–	11.36¶	1.055	18	–	1.70	8.94	76
Crawford Peach (not mellow),	–	11.88¶	1.045	22	–	1.67	5.92	64

* One part Na_2CO_3 in 100 parts of water.

† Picked October 9.

‡ Picked September 7.

§ Free acid, 2.25 per cent.

‖ Free acid, 2.43 per cent.

¶ In pulp, kept ten days before testing.

C. *Analyses of Fruits* — Continued.

[Wild and cultivated grapes.]

NAME.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1876.			Per ct.	Per ct.	Per ct.	C.C.
Concord, ...	July 17,	1.0175	31	8.30	.645	7.77	–
Concord, ...	July 20,	1.0150	31	8.10	.625	7.72	216
Concord, ...	Aug. 2,	1.0200	25	9.94	.938	9.44	249
Concord, ...	Aug. 16,	1.0250	28	10.88	2.000	18.38	229
Concord, ...	Aug. 30,	1.0500	25	15.58	8.620	55.33	120
Concord, ...	Sept. 13,	1.0670	23	17.48	13.890	79.46	55
Concord, ...	Sept. 4,	1.0700	18	19.82	16.130	81.38	49.2
Wild Purple Grape, ...	July 19,	1.020	31	9.00	.714	7.93	204
Wild Purple Grape, ...	Aug. 4,	1.020	28	12.25	1.100	8.98	246
Wild Purple Grape, ...	Aug. 16,	1.025	28	12.48	2.000	16.03	233
Wild Purple Grape, ...	Aug. 30,	1.050	26	16.58	6.500	39.81	147.6
White Wild Grape, ...	Aug. 31,	1.050	26	16.48	9.260	56.18	98
Hartford Prolific, ...	Sept. 5,	1.060	22	17.39	13.89	79.87	88.8
Ives' seedling, ...	Sept. 6,	1.070	26	20.15	15.15	75.14	88.6
Iona, ...	Sept. 7,	1.080	21	24.56	15.15	61.68	144
Iona (mildewed), ...	Sept. 7,	1.045	26	15.41	6.25	40.56	204.4
Agawam, ...	Sept. 11,	1.075	20	20.79	17.24	82.92	94.8
Wilder, ...	Sept. 11,	1.064	20	16.53	13.67	82.69	56
Delaware, ...	Sept. 12,	1.080	24	23.47	17.86	76.09	74
Charter Oak, ...	Sept. 12,	1.080	24	15.98	8.77	54.94	168.3
Israella, ...	Sept. 16,	1.075	23	19.67	9.20	46.77	89.8
Bent's Seedling, ...	Sept. 20,	1.080	21	20.65	16.13	78.11	181.8
Adirondack, ...	Sept. 20,	1.065	21	15.11	13.17	87.16	68
Catawba, ...	Oct. 16,	1.080	13	23.45	17.39	74.16	82
	1877.						
Wilder, ...	Sept. 11,	1.065	23	16.41	15.15	92.32	60
Charter Oak, ...	Sept. 12,	1.055	23	16.22	9.80	60.42	96
Concord, ...	Sept. 13,	1.065	24	15.90	13.16	82.76	102
Concord, ...	Sept. 26,	1.075	24	19.34	15.43	79.78	70.8
Eumalan, ...	Sept. 24,	1.065	16	19.62	13.16	67.07	73
Wild White Grape, ...	Sept. 5,	1.050	22	15.57	7.20	46.24	140.8
Wild White Grape (shrivelled), .	Sept. 20,	1.060	16	20.02	10.00	49.95	130
Wild Purple Grape (shrivelled), .	Sept. 20,	1.045	16	16.69	8.22	49.25	104

* One part of pure $Na_2 CO_3$ in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of girdling on grapes.]

NAME AND CONDITION.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter at 100° C.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.			Per ct.	Per ct.	Per ct.	C. C.
Hartford Prolific, not girdled,	Sept. 3,	1.045	19	12.85	8.77	68.25	111.4
Hartford Prolific, girdled,	Sept. 3,	1.065	19	17.18	12.50	72.76	100
Wilder, not girdled,	Sept. 3,	1.055	19	15.41	10.42	67.62	108.2
Wilder, girdled,	Sept. 3,	1.075	19	17.24	14.70	85.26	88.4
Delaware, not girdled,	Sept. 4,	1.065	19	15.75	11.76	74.66	101.2
Delaware, girdled,	Sept. 4,	1.075	19	19.14	15.15	79.16	94.4
Agawam, not girdled,	Sept. 4,	1.060	19	16.60	11.37	68.48	128.2
Agawam, girdled,	Sept. 4,	1 075	19	18.45	16.31	87.42	114.8
Iona, not girdled,	Sept. 6,	1.0625	22	16.60	13.51	68.31	131.4
Iona, girdled,	Sept. 6,	1.085	22	21.48	15 63	72.76	125.6
Concord, not girdled,	Sept. 6,	1.045	22	13.46	7.46	55.42	182.4
Concord, girdled,	Sept. 6,	1.070	22	17.53	13.88	79.18	102.8
Concord, not girdled,	Sept. 26,	1.065	22	17.63	13.70	78.27	86
Concord, girdled,	Sept. 26,	1.080	22	24.47	19.61	80.13	76.8
Concord, not girdled,	Oct. 5,	1.075	12	20.92	17.50	85.37	42
Concord, girdled,	Oct. 5,	1.085	12	–	17.86	–	54

	Date.	100 Parts of Grapes contained —			
		Ash.	Moisture.	Glucose.	Tartaric Acid.
	1889.				
Concord, not girdled,	Sept. 23,	–	84.69	6.24	.75
Concord, girdled,	Sept. 23,	.42	83.00	8.13	.85
Concord, not girdled,	Oct. 8,	.53	84.51	6.09	.48
Concord, girdled,	Oct. 8,	.37	82.69	8.50	.50
	1890.				
Concord, not girdled,	Sept. 25,	.47	86.49	7.36	1.15
Concord, girdled,	Sept. 25,	.48	84.93	9.29	1.17
Concord, not girdled,	Oct. 9,	.53	85.39	7.67	.71
Concord, not girdled,	Oct. 9,	.59	85.11	6.65	.51
Concord, girdled,	Oct. 9,	.54	85.15	9.12	.74

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* One part of pure $Na_2 CO_3$ in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of fertilization upon the organic constituents of wild grapes.]

NAME.	Date.	Dry Matter.	Specific Gravity.	Temperature C. (Degrees).	Per Cent. of Glucose.	Per Cent. of Acids.	Remarks.
	1877.						
Wild Purple Grape Berries, .	Sept. 20,	16.31	-	-	8.03	-	Unfertilized.
Wild Purple Grape Berries, .	"	19.55	-	-	13.51	-	Fertilized.
Wild Purple Grape Juice, .	"	-	1.045	16	8.22	9 840	Unfertilized.
Wild Purple Grape Juice, .	"	-	1.065	16	13.51	1.149	Fertilized.
Wild White Grape Berries, .	"	20.02	-	-	-	-	Unfertilized.
Wild White Grape Berries, .	"	21.65	-	-	-	-	Fertilized.
Wild White Grape Juice, .	"	-	1.060	16	10.00	1.846	Unfertilized.
Wild White Grape Juice, .	"	-	-	-	14.29	.923	Fertilized.

[Effect of fertilization upon the ash constituents of grapes.]

NAME.	Date.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Remarks.
	1876.								
Wild Purple Grapes,	Sept. 13,	50.93	.15	22.23	5.59	.79	17.40	2.93	Unfertilized.
Wild Purple Grapes,	Sept. 20,	62.65	.85	14.24	3.92	.53	13.18	4.63	Fertilized.
Concord Grapes, .	July 7,	41.73	5.04	25.03	7.80	.55	18.48	1.37	Unfertilized.
Concord Grapes, .	July 17,	47.34	1.13	24.21	-	.75	21.38	.43	Unfertilized.
Concord Grapes, .	Aug. 18,	51.14	3.19	16.20	6 38	.65	20.77	1.67	Unfertilized.
Concord Grapes, .	Sept. 13,	57.15	4.17	11.30	3.10	.40	12.47	11.82	Unfertilized.
	1878.								
Concord Grapes, .	Oct. 3,	64.65	1.42	9.13	3.63	.50	14.87	5.80	Fertilized.

C. Analyses of Fruits — Concluded.

[Ash analyses of fruits and garden crops.]

NAME.	Ash.	100 PARTS OF ASH CONTAINED —						
		Potash.	Soda.	Lime.	Magnesia.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.
Concord Grape (fruit), . .	–	51.14	3.19	16.20	6.38	.65	20.77	1.67
Unfermented juice, . .	–	50.85	.48	3.69	4.25	.10	6.43	.90
Fermented juice, . .	–	40.69	–	6.85	6.24	–	9.04	–
Skins and pulp, . . .	–	7.70	.42	57.36	8.80	.08	24.40	1.32
Seeds, ...	3.08	6.71	–	–	3.03	–	17.20	.29
Stems of grapes, . . .	4.69	20.91	–	20.20	8.45	–	17.75	2.09
Young branches,* . .	–	24.71	.94	40.53	10.66	1.08	17.16	4.92
Wood of vine,† . . .	2.97	22.57	–	9.72	4.28	–	14.07	23.84
Concord Grapes, 1891,‡ . .	.55	49.76	–	3.50	2.53	1.19	13.56	2.01
Clinton Grape (fruit), . .	–	58.45	3.51	13.34	7.37	.90	18.19	–
Baldwin Apple, ...	–	63.54	1.71	7.28	5.52	1.08	20.87	3.68
Strawberry (fruit),§ . . .	.52	49.24	3.23	13.47	8.12	1.74	18.50	5.66
Strawberry (fruit),‖ . . .	–	58.47	–	14.64	6.12	3.37	17.40	–
Strawberry vines, . . .	3.34	10.62	13.35	36.63	3.83	6.91	14.48	14.17
Cranberry (fruit), . . .	.18	47.96	6.58	18.58	6.78	–	14.27	–
Cranberry vines, . . .	2.45	12.98	3.27	16.49	10.33	3.35	10.94	34.04
Currants, red, ...	.47	47.68	4.02	18.96	6.23	1.20	21.91	–
Currants, white, . . .	.59	52.79	3.00	17.08	5.68	2.67	18.78	–
Crawford Peach, sound, . .	–	74.46	–	2.64	6.29	.58	16.02	–
Crawford Peach, diseased,¶ .	–	71.30	–	4.68	5.49	.46	18.07	–
Branch, sound, . . .	–	26.01	–	54.52	7.58	.52	11.37	–
Branch, diseased,¶ . .	–	15.67	–	64.23	10.28	1.45	8.37	–
Carnation Pinks (whole plant),**	8.80	38.07	12.84	18.64	3.98	.34	5.23	.24
Asparagus stems, . . .	–	42.94	3.58	27.18	12.77	1.22	12.31	.08
Asparagus roots, . . .	–	56.43	5.42	15.48	7.57	–	15.09	3.67
Onions, ...	–	38.51	1.90	8.20	3.65	.58	15.80	3.33

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* With tendrils and blossoms.

† One year old.

‡ Nitrogen in dry matter, .96 per cent.

§ Wilder.

‖ Downing.

¶ Yellows.

** Nitrogen in dry matter, 1.15 per cent.

D. *Analyses of Sugar-producing Plants.*

[Composition of sugar beets raised upon the college grounds during the season of 1870 and 1871.]

NAME.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Sugar.	Non-saccharine Substances.
Electoral, ...	Sept. 10,	14	12.30	1.75
Imperial, ...	" 12,	15	12.59	2.41
Vilmorin, ...	" 13,	14.5	12.95	1.55
Imperial, ...	" 18,	14	10.79	3.21
Imperial, ...	Oct. 11,	15	12.05	2.95
Electoral, ...	" 16,	15	12.22	2.78
Vilmorin, ...	" 18,	16	13.13	2.87
Imperial, ...	Nov. 14,	15	11.60	3.34
Vilmorin, ...	" 21,	15.5	13.12	2.38
Vienna Globe,*	Sept 19,	11	8.00	3.00
Common Mangold,* . . .	" 19,	9	5.00	3.97

* Fodder beets.

[Percentage of sugar in different varieties of sugar beets grown on college farm during the season of 1882.]

NAME.	Source of Seed.	Weight in Pounds.	Per Cent. of Sugar in Juice.
I. Vilmorin, ...	Saxony, .	¾ to ⅞	15.50
II. Vilmorin, ...	Saxony, .	¾ to 1	15.61
I. White Imperial, ...	Saxony, .	¾ to 1¾	14.20
II. White Imperial, ...	Saxony, .	1¾ to 2	10.27
New Imperial, ...	Saxony, .	1¼ to 1¾	13.80
I. White Magdeburg, ...	Saxony, .	1½ to 2	13.10
II White Magdeburg, ...	Silesia, .	1½ to 1¾	10.06
Quedlinburg, ...	Saxony, .	1½ to 1¾	13.44
White Silesian, ...	Silesia, .	1¼ to 1½	9.72

D. Analyses of Sugar-producing Plants — Continued.

[Effect of soil and fertilization on Electoral sugar beets.*]

SOIL.	MANURE.	Specific Gravity Brix (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine Substances.	Cane Sugar in Soluble Matter.
Sandy loam,	Fresh yard-manure,	16.5	12.50	4.00	75.08
Clayish loam,	Fresh yard-manure,	15.5	11.05	4.45	71.30
Warm alluvial,	Yard-manure and chemicals,	12.75	9.17	3.58	71.92
Warm alluvial,	Fresh hog-manure,	13.5	9.53	3.97	70.06
Light, sandy soil,	No manure,	18.5	13.73	4.77	74.21
Alluvial soil,	Brighton fish,	14.5	11.15	3.35	76.90
Heavy soil,	Yard-manure,	12.25	8.15	4.10	66.53
–	–	13.5	9.90	3.60	73.33

* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.*]

FERTILIZERS.	PERCENTAGES OF SUGAR IN JUICE.		
	Freeport.	Electoral.	Vilmorin.
Fresh horse-manure,	11.96	9.42	7.80
Blood guano without potash,	10.99	10.10	10.20
Blood guano with potash,	12.55	13.24	10.50
Kainite and superphosphate,	13.15	12.16	10.50
Sulphate of potash,	14.52	14.32	12.78
Second year after stable-manure,	13.49	12.78	12.19

* All were grown on the same soil, — sandy loam (college).

D. Analyses of Sugar-producing Plants — Continued.

[Effect of different modes of cultivation on Electoral sugar beets.]

Locality of Beet-field.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Cane Sugar.	Non-saccharine Substances.
1. Sing Sing, N. Y.,	1872–73	11	7.80	3.20
2. Washington, N. Y.,	"	14	10.97	3.03
3. South Hartford, N. Y.,	"	15	11.70	3.30
4. Greenwich, N. Y.,	"	12	9.50	2.50
5. Frankfort, N. Y.,	"	13.5	11.00	2.50
6. Albion, N. Y.,*	"	18	15.10	2.90
Albion, N. Y.,†	"	14	9.70	4.30

* From beets weighing from 1½ to 2 pounds. † From beets weighing from 10 to 14 pounds.

1. Soil, loam resting on clayish hard-pan, had been for several years in grass. Tomatoes had been the preceding crop. Five hundred pounds of a phosphatic blood guano were applied before planting.

2. Soil, a clayish loam, had been ploughed seven inches deep. A liberal amount of rotten sheep-manure was placed in trenches and covered by running two furrows together, thus forming a ridge on which the seed were planted.

3. Soil, a gravelly loam, which had been richly manured with stable compost and twice ploughed before planting.

4. Soil, a sandy loam, underlaid by fine sand. The seed were planted on ridges, which covered trenches containing a little rotten stable-manure.

5. No details of modes of cultivation received.

6. Soil, a dark, reddish-brown, rich, deep, sandy loam. Clover had been raised for two years previous to a crop of carrots, which preceded the sugar beets. The beets were the second crop after the application of twenty loads of stable-manure per acre.

Composition of Canada-grown Sugar Beets.

[1872 and 1873.]

Where Grown.	Weight of Roots.	Specific Gravity of Juice (Brix).	Temperature of Juice.	Per Cent. of Cane Sugar in Juice.
Echaullon de Montreal,	2 to 2½ lbs.	15.4°	64° F.	11.38
Riviere du Loup,	2 to 3¼ lbs.	14.5°	63° F.	10.20
Chambly,	2 to 2½ lbs.	13.2°	63° F.	9.02
Maskinonge,	2 to 3 lbs.	13.4°	63° F.	8.83

D. Analyses of Sugar-producing Plants — Continued.

[Early Amber Cane.]

DATE.	CONDITION OF CANE.	Brix Saccharometer (Degrees).	Temperature C. (Degrees).	Glucose.	Cane Sugar.	Soda solution required to neutralize 100 parts of Juice.	Solids.
1879.				Per ct.	Per ct.	C. C.	Per ct.
Aug. 15,	No flower stalks in sight,* . .	4.2	27	2.48	None.	6.8	7.93
Aug. 16,	No flower stalks in sight,* . .	5.8	24	4.06	None.	9.0	11.10
Aug. 20,	Flower stalks developed,* . .	7.9	24	3.47	2.15	7.0	13.00
Aug. 24,	Flowers open,*	8.7	23	3.70	3.00	4.0	14.07
Aug. 27,	Plants in full bloom,* . . .	10.0	25	3.65	4.13	10.0	15.48
Aug. 30,	Seed forming,*	9.5	30	4.00	3.81	9.5	16.14
Sept. 2,	Seed in milk,*	10.7	27	3.85	4.41	9.5	15.85
Sept. 9,	Seeds still soft,*	12.1	22	3.21	6.86	9.5	26.13
Sept. 9,	Stripped on Sept. 2,*	12.8	22	3.77	6.81	9.5	26.75
Sept. 18,	Left on field without stripping,* .	13.2	22	3.57	7.65	–	–
Sept. 18,	Tops removed,*	13.8	22	3.16	8.49	–	–
Sept. 18,	Tops and leaves removed on Sept. 9,*	11.5	22	3.16	5.85	–	–
Sept. 18,	Tops removed; left on field 9 days,*	12.8	22	10.00	.60	–	–
Sept. 21,	Juice from the above,* . . .	13.0	21	–	–	–	–
Sept. 23,	Juice from the above,* . . .	15.0	18	–	–	–	–
Sept. 25,	Left on field 3 weeks,† . . .	19.8	21	11.91	6.27	–	–
Sept. 28,	Left on field 3 weeks,† . . .	17.8	12	16.60	–	–	–
Oct. 4,	Left on field 3 weeks,† . . .	16.1	17	8.62	6.16	12.0	–
Oct. 7,	Freshly cut. Ground with leaves,†	16.7	20	4.16	9.94	6.8	–
Oct. 8,	Freshly cut. Stripped two weeks,†	12.8	17	5.16	5.27	7.0	–
Oct. 9,	Freshly cut. Stripped two weeks,†	18.4	17	7.57	–	10.6	–
Oct. 14,	Several weeks old,†	18.2	15	10.42	–	10.4	–
Oct. 18,	Several weeks old,†	15.1	23	7.57	–	–	–
Oct. 19,	Several weeks old,†	15.5	15	9.22	–	13.6	–
Oct. 22,	Several weeks old,†	16.2	16	8.30	–	–	–
Oct. 23,	Several weeks old,†	18.3	17	11.30	5.5	14.0	–
Oct. 24,	Several weeks old,†	16.6	15	8.63	–	9.0	–

		100 PARTS OF CANE CONTAINED —				
		Moisture.	Glucose.	Cane Sugar.	Total Sugar.	
1889.						
October,	Early Tennessee sorghum, mature,	77.43	1.79	3.21	5.00	Grown on station grounds.
October,	Price's new hybrid, ripe, . . .	77.80	2.92	3.78	6.70	
October,	Kansas orange, green, . . .	80.67	2.38	3.63	6.01	
October,	New orange, green, ...	78.30	2.96	3.85	6.81	
October,	Honduras, green, ...	77.55	3.08	4.01	7.09	

* Raised on the college farm. † Raised by farmers in the vicinity of the college.

D. Analyses of Sugar-producing Plants — Concluded.

[Composition of the juice of corn stalks and melons.]

VARIETY.	Specific Gravity.	Temperature C. (Degrees).	Glucose.	Cane Sugar in Juice.	Solids.
			Per ct.	Per ct.	Per ct.
Northern corn,*	1.023	27	4.35	0.28	15.18
Black Mexican sweet corn,†	1.048	27	2.06	7.02	17.44
Evergreen sweet corn,†	1.052	–	4.85	5.70	20.38
Common sweet corn,‡	1.035	–	6.60	None.	–
Common yellow musk-melon,§	1.040	26	1.67	2.65	–
White-flesh water-melon,	1.025	18	2.91	2.16	–
Red-flesh water-melon,	1.025	22	3.57	2.18	–
Red-flesh water-melon,	1.025	19	3.84	1.77	–
Nutmeg musk-melon,‖	1.030	19	3.33	2.11	–
Nutmeg musk-melon,¶	1.050	20	2.27	5.38	–
Nutmeg musk-melon,**	1.030	19	2.50	1.43	–

* Tassels appearing.

† Ears ready for the table.

‡ Kernels somewhat hard.

§ Fully ripe.

‖ Not ripe.

¶ Ripe.

** Over-ripe.

E. *Analyses of Dairy Products.*

	Analyses.	Solids.			Fat.			Curd.			Salt.			Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	
Whole milk,	899	18.27	10.58	13.60	7.54	2.48	4.00	-	-	3.20	-	-	-	.70
Skim milk,	76	10.40	7.68	9.50	1.02	.20	.45	-	-	3.53	-	-	-	.80
Buttermilk,	18	9.86	7.40	8.16	.38	.15	.21	-	-	2.79	-	-	-	.80
Cream (from Cooley Creamer),	94	29.35	21.30	25.50	20.90	13.74	17.70	-	-	-	-	-	-	.62
Butter,	24	92.89	87.05	89.17	89.05	81.43	83.98	.89	.51	.66	6.45	3.61	4.80	-
Whole-milk cheese (Jersey),*	1	-	-	62.84	-	-	37.32	-	-	22.13	-	-	-	3.39
Whole-milk cheese,*	1	-	-	64.17	-	-	34.34	-	-	26.69	-	-	-	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	-	-	62.70	-	-	27.81	-	-	30.37	-	-	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	-	-	31.99	-	-	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	-	-	33.24	-	-	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	-	-	34.94	-	-	-	3.88
Cheese from skim-milk, with addition of buttermilk,*	1	-	-	51.62	-	-	18.35	-	-	28.63	-	-	-	4.64
Genuine oleomargarine cheese,*	1	-	-	62.10	-	-	31.66	-	-	25.94	-	-	-	4.50

* From analyses made in 1875.

E. *Salt for Meat Packing and Dairy Purposes.*

KIND AND SOURCE.	Moisture, 100° C.	Sodium Chloride.	Calcium Sulphate.	Calcium Chloride.	Magnesium Chloride.	Sodium Sulphate.	Magnesium Sulphate.	Insoluble Matter.	Remarks.
Rock salt of Peltite Anse, La.,	.330	98.882	.782	.004	.003	-	-	-	Sent on for examination.
Rock salt of Neyba, San Domingo, W. I.,	.300	98.330	1.480	-	.090	.070	.070	-	
Solar salt, Onondaga, N. Y.,	2.500	96.004	1.315	.092	.089	-	-	-	
Solar salt, Hocking Valley, O.,	2.130	97.512	None.	.234	.089	-	-	-	
Solar salt, Saginaw Valley, Mich.,	3.344	95.813	.316	.356	.140	-	-	-	
Solar salt from Kansas,	4.950	93.060	1.220	-	.240	.350	.180	-	
Solar salt, Lincoln County, Neb.,	1.200	98.130	.250	-	.080	.390	None.	-	
Common fine and boiled salt, Onondaga, N. Y.,	3.000	95.353	1.355	.155	.136	-	-	-	
Common fine and boiled salt, Portsmouth, Mich.,	6.752	90.682	.805	.974	.781	-	-	-	
Common fine and boiled salt, Mason City, O.,	3.470	95.789	-	.614	.041	-	-	-	
Dairy and table salt, Ashton's (English),	0.760	97.652	1.430	-	.060	-	.048	.050	
Onondaga dairy salt,	0.700	97.832	1.263	-	.037	.026	.023	.120	
Fine salt, Bulletin 26, I.,	3.280	95.091	1.487	.032	.075	-	-	.035	
Fine salt, Bulletin 26, II.,	4.591	94.012	1.177	.143	.049	-	-	.028	
Fine salt, Bulletin 26, III.,	4.616	94.236	.999	.071	.026	-	-	.052	Salicylic acid: trace.
Dairy salt, sent on from Amherst, Mass.,	0.145	98.520	1.009	.189	.065	-	-	.072	
Ashton salt (sent on),	.760	97.650	1.430	-	.060	-	.050	.050	
Onondaga factory-filled (sent on),	.600	98.280	.910	-	-	.030	.060	.120	
Dairy salt, sent on from Amherst,	.505	98.202	.877	.168	.046	-	-	.202	
Rock salt from Retsof salt mines,	2.600	95.940	.420	.330	.010	-	-	.700	
Royal salt,	.880	97.877	1.108	.016	.010	-	-	.102	
Excelsior salt,	.320	98.009	1.644	.013	.014	-	-	.020	
Genesee salt,	.295	98.513	1.160	.010	.012	-	-	.010	
Genesee salt,	.235	98.563	1.137	.045	.020	-	-	-	
Bradley salt,	.200	98.575	1.185	.029	.007	-	-	-	
Higgins' Eureka salt,	.855	98.891	.906	.293	.055	-	-	-	
Worcester refined salt,	.565	97.935	1.376	.097	.027	-	-	-	

F. Analyses of Insecticides.

	Moisture.	Arsenious Oxide.	Copper Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and AluminicOxides.	Insoluble Matter.
Paris green, ...	1.30	62.55	32.84	3.10	-	-	-	-	-	-	-	-	0.21
Paris green, ...	1.41	61.40	33.20	3.90	-	-	-	-	-	-	-	-	0.09
Paris green, ...	1.40	61.15	33.10	3.71	-	-	-	-	-	-	-	-	0.64
Paris green, ...	1.15	59.92	30.40	-	-	-	-	-	-	-	-	-	0.10
Paris green, ...	1.34	61.25	33.35	3.93	-	-	-	-	-	-	-	-	0.13
Paris green, ...	1.31	61.21	33.45	3.94	-	-	-	-	-	-	-	-	0.09
"Sulphatine,"	1.40	-	2.61	-	-	-	48.28	4.73	-	18.60	-	-	1.63
"Death to Rose Bugs,"	2.95	-	1.05	-	-	-	34.53	4.35	-	17.76	-	-	0.49
"Professor De Graff's Carpet Bug Destroyer," . . .	95.81	-	-	-	-	0.78	-	0.48	0.27	-	0.26	0.90	-
Tobacco liquor, ...	37.71	-	-	-	2.12	-	-	-	-	3.07	6.55	0.23	-
Tobacco liquor, ...	40.89	-	-	-	0.53	-	-	-	-	1.47	16.34	0.01	-
Tobacco liquor, ...	-	-	-	-	4.55	-	-	-	-	-	-	-	-
Tobacco liquor, ...	-	-	-	-	4.82	-	-	-	-	-	-	-	-
"Nicotinia,"	10.00	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore, ...	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore, ...	-	-	-	-	-	-	-	-	-	-	-	-	38.12
"Peroxide of Silicate,"	1.65	0.57	0.33	-	-	-	-	49.66	-	41.18	-	-	2.31

METEOROLOGY.

1891.

The meteorological observations have been continued as in previous years. The temperature, the force and the direction of the wind and the amount of cloudiness are recorded each day at 7 A.M., 2 P.M. and 9 P.M. During the summer months the reading of a wet-bulb thermometer takes place at the same times. Records are also taken of maximum and minimum temperatures, rainfall, and of casual meteorological phenomena.

Monthly and annual reports are sent to the headquarters of the signal service at Washington, D. C., and to the New England Meteorological Society. During the summer months partial monthly reports have been furnished also for the use of the secretary of the State Board of Agriculture.

At the beginning of the year there were nine inches of snow on the ground. The total snowfall of the season after January 1 amounted to fifty-eight inches. The heaviest snow-storm during the time occurred January 25, measuring thirteen inches. A storm giving twelve inches of snow occurred on the 3d and 4th of March. The last snow of this part of the season fell on the 2d and 3d of April. Sleighing was good most of the time until the 10th of March. A snow-storm on the 26th of November amounted to one and one-half inches. The snowfall during December was very light. The precipitation of moisture (rain and snow) during the year was below the average and unevenly distributed.

The largest amount of water falling in one month was 6.61 inches, January; the smallest amount 1.98 inches, November. The heaviest storm of the year occurred from the 2d to the 4th of June, with 2.92 inches of rainfall. The largest amount of rain falling in any one day was 1.73 inches, June 2.

The rainfall during April and May was light, otherwise the early part of the season was favorable for farm crops. The large number of rainy days during July and August interfered to some extent with haying and harvesting. The rainfall for the months September, October and November was much below the usual average. A scarcity of water was seriously felt in many localities of this vicinity.

The last heavy frost of the season occurred on the 19th of May; there was a slight one on the 5th of June. No frost was noticed in the autumn before October 10.

The mean annual temperature for the year was 47.62° F., which is slightly above the average. The monthly average temperatures did not vary much from those of former years except during September, which was considerably warmer than usual.

The highest temperature for the year, 93° F., occurred June 16; the lowest, —5.5, February 15.

The prevailing wind during six months of the year came from the north-east. It was north-west during April and May, south during July, and south-east during September, November and December.

During the year there were one hundred and forty-five days recorded as "cloudy," seventy-nine as "cloudless." The greatest number of cloudy days, fifteen, occurred in January, and the greatest number of cloudless days, eight, in November and December.

Summary of Meteorological Observations, 1891.

	TEMPERATURE, DEGREES FAHRENHEIT.											RELATIVE HUMIDITY, PER CENT.				PRECIPITATION, INCHES.	
	7 A. M.	2 P. M.	9 P. M.	Mean.	Maximum.	Minimum.	Range.	Absolute Maximum.	Date.	Absolute Minimum.	Date.	7 A. M.	2 P. M.	9 P. M.	Mean.	Depth of Water.	Date of Greatest Fall.
January, ...	21.7	30.3	26.6	26.3	41.5	14.4	27.1	50.5	22d	—1.0	10th	-	-	-		6.61	22d
February, ...	23.4	32.1	27.2	27.5	47.9	10.4	37.5	53.5	25th	—5.5	15th	-	-	-	-	3.84	9th, 10th
March, ...	27.2	37.7	31.7	32.1	44.5	10.2	34.3	55.5	29th	—1.0	2d	-	-	-	-	2.89	8th, 9th
April, ...	41.6	55.2	45.4	46.9	64.0	10.8	33.2	77.0	30th	18.0	6th	-	-	-	-	2.74	11th
May, ...	49.3	64.4	53.4	55.2	68.1	37.4	37.0	86.0	10th	25.0	6th	79.0	56.2	71.5	68.9	1.82	29th
June, ...	59.6	74.6	62.8	64.9	77.1	49.3	27.8	93.0	16th	34.5	5th	87.7	60.8	80.2	76.2	4.61	2d
July, ...	61.7	74.2	64.4	66.2	76.2	58.6	17.6	89.0	13th	42.0	28th	87.4	62.4	81.9	77.2	5.09	30th
August, ...	63.9	76.3	66.6	68.3	77.4	58.8	18.6	90.0	11th	46.0	1st	90.9	66.1	86.6	81.2	3.67	28th
September, . . .	57.8	73.0	61.7	63.6	75.0	50.5	24.5	89.0	18th	37.0	9th	95.7	64.4	87.4	82.5	2.22	29th
October, ...	41.4	56.8	46.0	47.5	67.2	33.0	34.2	87.0	4th	21.0	29th	88.4	62.6	82.5	77.8	2.56	20th
November, . . .	32.3	45.1	35.2	37.0	56.0	14.6	41.4	63.0	11th	4.0	30th	-	-	-	-	1.98	16th, 17th
December, . . .	31.0	42.3	35.2	35.9	52.9	12.8	40.1	58.5	4th	9.0	17th	-	-	-	-	4.55	29th, 30th
Sums, . . .	510.9	662.0	556.2	571.4	747.8	380.8	367.0	892.0	-	229.0	-	529.1	372.5	490.1	463.8	42.58	-
Mean, . . .	42.57	55.17	46.35	47.62	62.32	31.73	30.58	74.33	-	19.08	-	88.18	62.08	81.68	77.30	3.55	-

Miscellaneous Phenomena, — Dates.

	Frost.	Snow.	Rain.	Thunder-storms.	Lunar Halos.	Solar Halos.
1891.						
January, .	-	1, 5, 14, 17, 18, 25, 27, 29.	1, 11, 12, 17, 18, 22, 29, 31.	2,	15,	-
February, .	-	7, 8, 9, 20, 26,	1, 3, 9, 10, 16, 17, 18, 21, 25.	-	15, 19,	6, 28.
March, . .	-	3, 4,	8, 9, 12, 13, 21, 22.	-	18,	27, 31.
April, . .	-	2, 3,	11, 14,	15, 18,	-	-
May, . .	19,	-	3, 6, 15, 16, 21, 29.	11, 26,	20,	2.
June, . .	5,	-	4, 17, 18, 19, 21, 22.	2, 3,	11,	-
July, . .	-	-	4, 7, 8, 18, 24, 28, 29, 30.	15, 25,	-	-
August, . .	-	-	4, 5, 21, 22, 23, 24, 26, 27.	7, 12, 15, 18, 28.	-	-
September, .	-	-	5, 6,	13, 29,	11,	-
October, .	10, 12, 16, 17, 24, 25, 29, 30.	-	7, 8, 13, 26, 27,	20,	-	-
November, .	3, 4, 5, 7, 8, 13, 14, 15, 19, 20, 21, 26.	26,	10, 11, 16, 17, 23, 26, 27, 28.	-	19,	-
December, .	1, 12, 13, 28, 29.	-	4, 7, 15, 16, 22, 23, 24, 26, 29, 30.	-	9, 19,	-

AMHERST, MASS.

C. A. GOESSMANN,
Director.

ANNUAL REPORT OF FRANK E. PAIGE,

Treasurer of the Massachusetts Agricultural Experiment Station,

For the Year ending Dec. 31, 1891.

Received.		
Cash on hand from last year,	$343 86	
Cash from State Treasurer, appropriation,	10,000 00	
Cash from fertilizer account,	2,250 00	
Cash from expense,	325 00	
Cash from farm,	978 71	
		$13,897 57
Expended.		
Cash paid salaries,	$5,243 31	
Cash paid laboratory supplies,	738 43	
Cash paid printing and office expenses,	680 75	
Cash paid farmer and farm labor,	2,330 24	
Cash paid farm supplies,	1,505 47	
Cash paid incidental expenses,	528 66	
Cash paid construction and repairs,	138 77	
Cash paid expense of board of control,	138 63	
Cash paid fertilizer account,	2,590 00	
Cash on hand,	3 31	
		$13,897 57

Summary of the Property of the Massachusetts State Agricultural Experiment Station.

(Dec. 31, 1891.)

Farm:		
Live stock,	$821 00	
Tools, implements and machinery,	935 95	
Produce on hand,	607 20	
Fertilizers,	72 67	
Chemical Laboratory:		
Laboratory inventory,	2,740 27	
Office furniture,	1,617 00	
Agricultural and Physiological Laboratory:		
Furniture, herbariums, library (first floor),	734 75	
Instruments, apparatus, etc. (first floor),	691 20	
Furniture (second floor),	394 52	
Instruments, apparatus, etc. (second floor),	369 90	
Buildings, land, etc.,	32,202 00	
Total of inventory,		$41,186 46

Boston, Mass., Jan. 14, 1892.

This is to certify that I have examined the books and accounts of Frank E. Paige, Treasurer of the Massachusetts Agricultural Experiment Station, for the fiscal year ending Dec. 31, 1891, and find them correct, and all disbursements properly vouched for, with a balance in the treasury of three dollars and thirty-one cents, which is shown to be in bank.

W. R. SESSIONS,
Auditor.

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